POLICY BRIEF

Efforts to Improve Non-Academic Career Outcomes among University Postdocs

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PROBLEM

Most postdocs will not find tenure-track academic employment. Given the gap between the growing supply of postdocs and limited supply of academic jobs, many postdocs will seek employment not closely related to his or her academic training and education, which is educational mismatch. This results in deleterious effects to individual postdocs and embodies the under-utilization of publicly-funded human capital.

SUGGESTED POLICY CHANGES

Legislative Policy

- Revisit existing policy such as the America COMPETES Reauthorization Act and include language that specifically addresses postdoc career attainment.
- Consider including postdocs in state-level higher education and workforce development policies with provisions for employment support.
- Support state-level innovation policy that specifically fosters postdoc entrepreneurship incubation.
- Encourage the establishment of state-level postdoc employment task force that includes collaboration among labor, education, economic departments.
- Establish a congressionally-mandated blue ribbon commission to reimagine the postdoc to emphasize preparation for non-academic careers.

Programmatic Policy

- Broaden the scope of IDPs to include non-academic careers and include access to mentoring and services in support of these contingency plans.
- Following the role of entrepreneurship support services and TTO internships as de facto career training grounds for postdocs, investigate ways to align university, state, and federal efforts to accelerate technology transfer and commercialization efforts with postdoc career services.
- Similarly, explore the alignment of state and federal-level university-industry partnership grants to involve postdoc experiential non-academic career training.
- Augment current survey instruments to include information that can highlight the difficulty or ease by which postdocs obtain non-academic employment, including factors that improve or impede their transition.

POTENTIAL IMPACTS OF THESE CHANGES:

We anticipate better career preparation and subsequent placement of postdocs. Relatedly, we expect increased and more diverse scientific output across various STEM sectors.

This project shows that university postdocs ascribe to key elements of educational mismatch, resulting in deleterious effects to individual postdocs and embodies the under-utilization of publicly-funded human capital. The result of postdocs being unable to find academic employment commensurate with their training speaks to the need for important changes to the postdoc experience, particularly in the form of policy, programmatic and social support. In this report, literature about PhD and postdoc career development outcomes and experiences is reviewed, with a particular focus on individual, faculty and programmatic factors. Then, additional research is conducted by the authors. Lastly, the authors provide recommendations that can mitigate some of the reviewed challenges.

1. Introduction

1.1. University Postdocs

Academic postdoctoral fellow or scholar positions (hereafter called "postdocs") are critical to the scientific progress of society (e.g. Conti and Liu, 2015). Postdocs are defined as individuals holding a PhD engaged in a temporary period of mentored research or scholarly training (Lin and Chiu, 2015). These positions are relatively common among science and engineering PhDs: about 42 percent of PhDs graduating within the previous three years elect to become a university postdoc (NSF, 2013). The purpose of the postdoc position is to provide specialized scientific training and networks that will increase the chances that recently minted PhD students will obtain tenure-track faculty employment (Akerlind, 2005, 2009; Conti and Liu, 2015; Helbing et al., 1998; Horta, 2009; Melin, 2004; Recotillet, 2007; Su, 2013). In fields such as biology postdocs are a requisite for academic employment (Miller and Feldman, 2015; Nolan et al., 2004).

1.2. Defining the Problem

Most postdocs will not find tenure-track academic employment. National Science Foundation (NSF) indicators show rapid growth in university postdoc positions from 4,200 in 1973 to approximately 20,200 in 2013. The growth in postdoc positions combined with a relatively stagnant academic labor market means that, according to Puljak and Sharif (2009), fewer than 15 percent of postdocs will find tenure-track employment, though this figure varies by field. For example, Sauermann and Roach (2016) report that only 10.6 percent of PhDs graduating in the previous five years from life and biological science programs are employed in tenure track faculty positions. Academic job prospects are unlikely to change in the near term (Cyranoski et al. 2011; Fox and Stephan, 2001; Sauermann and Roach, 2010; 2012; Smaglik, 2014).

Given the gap between the growing supply of postdocs and limited supply of academic jobs, many postdocs will seek employment not closely related to his or her academic training and education. Scholars term this gap "educational mismatch" (e.g. Stenard and Sauermann, 2016). Educational mismatch results when (1) an individual is "overeducated" for the responsibilities of their job (e.g. Hartog, 2000; Hartog and Oosterbeek, 1988) or (2) do not possess the requisite skills required to succeed in their position (e.g. Allen and Van der Velden, 2001). Postdocs exhibit both of these dimensions.

2. Postdoc Transition to Non-academic Employment

We reviewed the scholarly literature to understand individual, principal investigator (PI), organizational and policy related factors mediating postdoc transition to non-academic employment. Given the early-stage nature of the research topic, we also reviewed literature relating to non-academic employment among PhDs. The sections below reflect the primary themes.

2.1. Individual-related Factors

Research shows that a number of factors among postdocs themselves may slow their transition to non-academic employment, including:

Heightened "Taste for Science": PhD education emphasizes the building of expertise and transformation of identity to that of a scholar, strongly influenced by the need to belong in and contribute to a department and discipline (Barnacle and Mewburn, 2010; Golde 1998; Henkel, 2005). During their socialization as scholars, PhDs and postdocs develop a heightened "taste for science", including the preference for the freedom to choose research projects, the ability to publish, and the desire to conduct basic research (Astebro and Thompson, 2011; Stern, 2004). These individuals strongly prefer academic careers over careers in industry (Roach and Sauermann, 2010). Akerlind (2009), for example, found that 73 percent of postdocs want an academic career, compared to 10 percent desiring a career in industry. For PhDs, career aspirations are reinforced by misinformation relating to an optimistic academic job market that may never materialize (Golde, 2005).

Poor Job Market Data: When PhDs realize the difficulties associated with obtaining an academic job, some often drop out of their respective programs (Golde, 2005), while others fail to understand job market dynamics until they become postdocs (Akerlind, 2009; Felisberti and Sear, 2014). Other studies show that more PhD students would consider pursuing non-academic careers in lieu of a postdoc position if they knew more about these opportunities (Garrison et al., 2016; Puljak and Sharif, 2009; Scaffidi and Berman, 2011). This also holds true for specific populations such as under-represented minority women (Gibbs and Griffin, 2013).

Non-academic Job Motivations: Some individuals do not limit themselves to academic jobs and enter PhD programs specifically to obtain a job in industry (Mangematin, 2000). In fact, significant numbers of PhDs scientists go into non-academic careers, especially in industry (Gibbs et al., 2014; Harman, 2002; Lee et al., 2010; Recotillet, 2007; Sauermann and Roach, 2012; Stephan et al., 2004), as their interest wanes in increasingly unattractive faculty careers (Fitzenberg and Schultze, 2014; Sauermann and Roach, 2012).

Poor Skills and Networks: If PhDs decide to explore non-academic career options, they generally do not possess the requisite networks or experience (Mangematin, 2000), nor do they understand how to translate their scientific knowledge into commercial opportunities (Hancock and Walsh, 2014). Thus, tensions exist between a PhD student's skills as an academic scientist and those required to obtain a job in industry (DeGrande et al., 2014; Hancock and Walsh, 2014; Salminen-Karlsson and Wallgren, 2008).

Stress: The realization that one may not obtain tenure-track academic employment constitutes a significant source of stress and, thus, postdocs remain in their positions—often extending their tenure several times—because they cannot otherwise find an academic job (Gaughan and Robin, 2004; Helbing et al., 1998; Puljak and Sharik, 2009).

2.2. PI-related factors

PIs not only recruit and supervise postdocs, they also provide mentoring critical to postdoc career development and job placement (Chen et al., 2015; van Balen et al., 2012; Miller, 2012). Factors that may impact the transition of postdocs to non-academic careers include:

PI socialization: Faculty are socialized over their career to adhere to specific disciplines, methods, and world views concerning the purpose of PhD education (Gardiner et al., 2014). Placing one's PhD student or postdoc into a tenure-track faculty position conforms to views among faculty that the purpose of PhD and postdoc programs is to train academic scientists. Such placement is also viewed as a sign of prestige. Thus, most faculty encourage PhD students to pursue academic research careers and eschew non-academic career alternatives (Akerlind, 2005; Sauermann and Roach, 2012; Stephan, 2012).

PI Views on the Purpose of a Postdoc: While many faculty view postdocs as a training position, others possess an instrumental view of postdocs "…not as apprentices but as skilled, bargain-rate assistants, who become increasingly valuable with time" (Singer, 2004, p. 232). Similarly, Puljak and Sharif (2009) find that PIs often lack incentive to adequately mentor postdocs and, instead, use them primarily to produce their grant applications and papers. Also, faculty often favor foreign postdocs not only because of their strong work ethic, but also because their visa status prohibits them from pursuing other employment opportunities (Cantwell and Lee, 2010; Cantwell and Taylor, 2013). In short, postdocs are critical for PI productivity.

Information and Networks: Among faculty that wish to help PhD students (and postdocs) find good jobs, many are uninformed about broader academic job market realities (Golde, 2005). Further, relating to non-academic career paths, faculty are unlikely to have the networks or backgrounds required to effectively mentor PhDs or postdocs on non-academic career options (Scaffidi and Berman, 2011). Nor do they have an idea of what skills might be useful within a non-academic context; when asked what skills are best for postdoc career possibilities, faculty emphasize number and quality of publications (Akerlind, 2005).

2.3. Organizational and policy-related factors

Universities, often in response to guidance from the federal government, establish policies and procedures for the postdoc position. A review of the literature finds little systematic investigation of the role of university and federal policies and programs. However, scholars articulate two factors that might help PhDs and Postdocs transition to non-academic employment, including job market information and preparation for non-academic careers.

Provide Job Market Information: In response to the challenges outlined above, scholars recommend that research universities provide individuals with academic job market information

before they commit to a PhD (Sauermann and Roach, 2012). Doctoral students should be encouraged to pursue non-academic scientific careers alternatives and receive skills and training that would allow them to do so (Akerlind, 2005; Harman, 2002; Sauermann and Roach, 2010). Further, PhDs and postdocs should be informed by universities and faculty that their academic *and* non-academic job opportunities diminish with age, thus, timing is critical (Fitzenberger and Schultze, 2014; Helbing et al., 1998).

Preparation for Non-Academic Careers: Critical to improving career outcomes among postdocs is mentoring that emphasizes myriad career possibilities beyond academia (Kaslow and Mascaro, 2007; Scaffidi and Berman, 2011; Singer, 2004). Davis (2009) suggests that positive social capital can accumulate as postdocs are offered developmental opportunities. These experiences include the opportunity to work in industry and other non-academic organizations (Fitzenberger and Schulze, 2014; Mangematin, 2000), chances to meet and listen to visiting representatives from industry (Gardiner et al., 2014), affiliation with industry cooperative research centers (Harman, 2002), and interdisciplinary research training (Boden et al., 2011; Holley, 2009), all of which help PhDs understand their career options and enable them to pursue these opportunities. The National Research Council (2000; 2014) recommends that institutions play a greater role in facilitating structured career-related mentoring; Leshner (2012) recommends that a national body be established to support institutional officials responsible for postdoc training, collect data important for decision-making and standard-setting, and understand best practices for the postdoc experience and career placement.

2.4. Summary

The sections above demonstrate that scholars have made important contributions to our understanding of factors associated with non-academic career outcomes among PhDs and postdocs. These studies focus primarily on PhD students (e.g. Hancock and Walsh, 2014; Mangematin, 2000), postdoc career outcomes in other countries (Akerlind, 2005; Fitzenberger and Schulze, 2014), or are descriptive in nature (Puljak and Sharif, 2009). Despite these contributions, little empirical work exists that explains factors that may impact the transition of postdocs to non-academic careers, as well as the resulting impact of educational mismatch, both promising topics for future research. What follows is a description of the research conducted by the project team, which supports the existing research and offers some additional insights.

3. Employer Perspectives

The project team interviewed 16 individuals from large companies and startup companies who had previously hired postdocs. The purpose of these interviews was to understand the extent to which industry found value in recruiting and hiring postdocs, as well the challenges with doing so. The secondary purpose was to supplement the literature review above, an especially important goal given that few studies attempt to understand employer perspectives on postdocs. The interviews yielded six themes, including:

- **Postdocs possess valuable scientific knowledge.** Employers represented companies that performed and utilized R&D in their business models. Though respondents differed by industry and thus scientific context, all reported that postdocs possessed value scientific knowledge and,

in the case of life science companies, were knowledgeable of cutting edge techniques and equipment use. While companies in other industries felt they did not fully utilize the scientific knowledge possessed by postdocs, they nonetheless reported that postdocs brought a valuable scientific perspective.

- **Postdocs bring valuable academic connections.** Several employers participating in the study found value in keeping abreast of cutting edge academic science and were able to do so through postdocs. Postdocs maintained social networks with their PIs, PhD classmates, and fellow postdocs who were not themselves in industry or in academia.

- **Postdocs have difficulty applying their research.** According to employers, it is difficult for postdocs to understand that once outside of academia, they must now apply their research to develop a specific product (in industry) or address a specific applied problem (in government labs), not just conduct research as an end unto itself.

- **Leadership and Teamwork.** Several employers mentioned that many postdocs do not possess leadership and teamwork capabilities, at least within the context of multi-functional teams that, within company units or startups, may integrate research, professional management, manufacturing, and sales functions.

- **Specific skill and cultural gaps.** Postdocs do not generally possess the background to work under strict deadlines and budgets, cancel projects that do not yield results within a specific period, make *brief* pitches or presentations, and communicate complex concepts to non-scientific audiences. Some employers found that postdocs (and PhDs) often needed to be directed to come into work at a designated time, attend regular meetings, and maintain a professional appearance.

- **Startups require flexibility.** According to employers from startups, these organizations require multi-dimensional skills and the ability to shift from task to task. The need for flexible skills is based on the rapid pace of change and need to quickly demonstrate results to investors. Postdocs are usually not socialized to be adaptable and handle myriad functional tasks.

Industry employers report that while the last four challenges above are common among all levels of education, postdocs generally require more time, compared to masters and PhD students, to acclimate to a non-academic career path. Further, industry and government respondents lamented that they might consider employing postdocs more often if they had been previously exposed to non-academic sectors and, even better, were prepared with skills that would allow them to quickly transition to and thrive within these environments.

4. Postdoc-oriented Career Preparation Programs Among Research Universities

The study team reviewed the websites of three hundred research universities ranked by R&D spending. Within this population, the team examined the extent to which universities made available postdoc career support programs focused on non-academic careers, recognizing that not all services may be listed online. First, the team cataloged all services listed on each website and

then inductively coded these services to identify major themes. Major categories among postdoc services included:

- *Non-academic services that provide experiential learning.* These services provide postdocs with hands-on experience (e.g. externships and shadowing) in industry and other non-academic environments.

- *Non-academic services that do not include experiential learning.* While these services do not include experience-based learning, they are designed to enable postdocs to pursue non-academic positions (e.g. CV/resume development and interview coaching).

- *No non-academic services listed, but academic career support services listed*. These services focused on preparing PhDs and postdocs to obtain tenure-track faculty positions.

- No career preparation services listed.

Once service-related themes were identified, the 300 universities were all coded accordingly. The table below summarizes the results.

Career Support Type	Number of Universities
Non-academic services including experiential learning experiences (including BEST programs)	28
Non-academic services without experiential learning experiences	88
No non-academic services listed, but academic career services listed	28
No career preparation services listed	156
Total	300

5. University Efforts to Improve Postdoc Career Prospects

To supplement the findings above, the project team interviewed nine career services representatives (with more to come) from each of the first three categories as reflected in the table above. The intention of the interviews was to provide greater understanding regarding motivations for the establishment of postdoc career services (especially those related to non-academic careers), specific services offered, as well as successes and opportunities relating to the programs. The sections below summarize the findings:

- **Rationale for creation of career services.** Postdoc program managers spoke of the critical and unfulfilled need for postdocs to receive better support in preparation for their academic career search.

- **Rationale for creation of non-academic career services.** As postdocs realized the possibility that they may not obtain a tenure-track academic research position, they requested assistance

from careers services offices for services that might help them prepare for non-academic career positions.

- **Organizational structure.** Postdoc career support services are administered by a stand-alone office (e.g. postdoc career support office) or are a component of a career services office for graduate students. Offices are generally modestly staffed, often with only one person or with a portion of an individual's time devoted to the function. Similarly, support staff may be shared; event planning and curriculum development staff may have 10 percent of their time designated for postdoc-related activities. Other part-time examples include faculty with part time administrative appointments, in addition to their traditional academic responsibilities.

  Collaboration with organizations such as the National Postdoc Association (NPA) and other academic units (e.g. business schools) help fill programming gaps. For example, NPA may take on the primary responsibility for organizing a networking event and rely upon the postdoc office to handle the administrative responsibilities (e.g. submitting receipts and securing space).

- **Specific career services available.** University representatives described the following career services provided to postdocs.
  - *Individual Development Plans (IDPs).* These plans walk postdocs through a personal assessment process to help them understand how their skills, strengths and interests may be translated into specific career paths. IDPs generally include steps to pursue these goals as well.
  - *CV/Resume Development and Interview Coaching.* Postdocs receive assistance in crafting more effective CVs and resumes as well as prepare them for interviews.
  - *Job Search Assistance.* Offices help postdocs understand how to conduct a job search, including guidance with specific job boards and posts.
  - *Academic Job Preparation.* Some offices provide workshops on effective writing (academic and grant) and research skills that can help postdocs increase their chances of obtaining faculty positions. Some offices also provide teaching opportunities to help build postdocs' teaching portfolio.

- **Specific non-academic career services available.** Some universities also provide postdocs with critical information about industry opportunities and expectations. Postdoc offices cultivate relationships with industry representatives to ensure their consistent participation. Alumni constitute an important source of industry connections, along with close proximity to industry hubs (e.g. technology and pharmaceuticals). Moreover, institutions with greater prestige may need to exert less effort to cultivate these relationships given that industry representatives may seek out these individuals.
  - *Industry Talks and Networking Events.* Universities that offer non-academic career services host regularly scheduled events with representatives from regional companies where they discuss the nature of their work, available positions, and how to prepare for these positions.
  - *Workshops and Curriculum.* Structured classes are offered to help postdocs translate their academic skill sets into valuable non-academic skills (e.g. learning the difference between research for academic and industry). They may also be taught important skills

such as communication, management, and budgeting. Classes may take the form of individual tutoring or group workshops and postdocs may receive a credential.
    - *Entrepreneurship Support Programs.* To broaden the non-academic job prospects of postdocs, representatives described the emerging interest among postdocs in entrepreneurship training and support services. While specific services vary, postdocs learn about transforming ideas into commercial opportunities, venture financing, and how to establish a startup company.

- **Examples of experiential programs.** Some universities also offer experiential learning opportunities to help postdocs develop relevant skills and increase their changes of obtaining non-academic employment. Services include:
    - *Externships, Internships, and Shadowing.* To maximize preparation for industry, some programs offer postdocs externships that allow postdocs to work in industry or other non-academic venues. In these capacities, postdocs are temporary employees assigned work that fits their scientific training yet contributes to the productivity and performance of the organization. Some universities provide postdocs with internships within university technology transfer offices where they learn the fundamentals of technology disclosure, evaluation, patenting, and commercialization. Both externships and internships are difficult to organize in institutions with unionized postdocs. To circumnavigate that challenge, postdocs may be instead offered opportunities to shadow an industry employee to expose them to the day-to-day duties of industry job tasks.
    - *Startup Experiences.* Though relatively uncommon among universities, emerging pilot programs not only to provide classes that introduce postdocs to entrepreneurship basics, they also ask participants to undertake applied projects that focus on the commercialization of university technologies. One university used components of the NSF iCorps program to guide postdoc projects; postdocs interview dozens of technologists as well as potential customers and investors to determine its potential and, if salient, guide its development path. For many postdocs, the program is the first time they have interacted with individuals outside of an academic environment, much less their lab.

- **Role of Faculty.** Postdoc support personnel spend enormous time and energy attempting to gain buy-in from PIs. They do so in hopes that faculty will not only *allow* postdocs to take advantages of careers services, but they will also encourage and support these efforts. Justifications include the importance of mentoring (including their articulation in federal guidelines), the ability for postdocs to acquire skills beneficial to labs, and the benefits of having happy and motivated postdocs who understand their career options. Unfortunately, some PIs refuse to support these efforts and—following recent research—view non-academic career support services as a distraction from the primary scientific responsibilities of postdocs or—perhaps worse—views the pursuit and acceptance of non-academic careers as professional failure.

- **BEST Program.** The Bettering Experiences in Science and Technology (BEST) grant program funded by the National Institutes of Health (NIH) provides an important source of funding and guidance for career development services, non-academic and otherwise. BEST

grants are awarded to institutions and campus-level BEST representatives find that the strength of the program lies in its structured nature, providing postdocs with sequenced services, including curriculum, mentoring, personal coaching, and non-academic career placement. However, the program faces two specific challenges. First, BEST focuses only on life science postdocs (i.e. funded by NIH) limiting its reach to non-life science postdocs. Second, BEST grants are awarded for two years meaning that financial sustainability may be difficult to achieve.

- **Summary.** Our interviews confirmed that:
  - Postdocs will generally not find academic employment.
  - Postdocs are thus in need of knowledge and skills that will allow them to pursue and obtain non-academic employment.
  - Universities increasingly recognize the importance of providing career services, including those that target non-academic careers.
  - These career services are relatively modest, with some programs focusing on providing experiential learning experiences for postdocs.
  - However, these services may not be offered for all postdocs beyond a specific discipline or lab.
  - Even when universities offer relevant services, broader barriers may exist, including the refusal of PIs to let postdocs take advantage of these services.

6. Proposed Solutions

Given the challenges to the transition of postdocs to non-academic employment, as well as efforts by universities and the federal government (through BEST) to assuage these challenges, this section offers several recommendations for next steps. Recommendations assume that subsequent policy action would not require substantial resources.

Legislative Policy

- Revisit existing policy such as the America COMPETES Reauthorization Act and include language that specifically addresses postdoc career attainment. This may include authorizing STEM related agencies to create incentives for industry collaborators to create career pipelines that culminates into placement.

- Consider including postdocs in state-level higher education and workforce development policies with provisions for employment support.

- Support state-level innovation policy that specifically fosters postdoc entrepreneurship incubation.

- Encourage the establishment of state-level postdoc employment task force that includes collaboration among labor, education, economic departments.

- Establish a congressionally-mandated blue ribbon commission to reimagine the postdoc to emphasize preparation for non-academic careers while also maintaining their important role in the conduct of science.

Programmatic Policy

- Broaden the scope of IDPs to include non-academic careers and include access to mentoring and services in support of these contingency plans.

- Following the role of entrepreneurship support services and TTO internships as de facto career training grounds for postdocs, investigate ways to align university, state, and federal efforts to accelerate technology transfer and commercialization efforts with postdoc career services.

- Similarly, explore the alignment of state and federal-level university-industry partnership grants to involve postdoc experiential non-academic career training.

- Augment current survey instruments to include information that can highlight the difficulty or ease by which postdocs obtain non-academic employment, including factors that improve or impede their transition.

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