Research Policy 45 (2016) 1291–1303

Contents lists available at ScienceDirect

Research Policy

journal homepage: www.elsevier.com/locate/respol

Training the scientific workforce: Does funding mechanism matter?

Margaret E. Blume-Kohout[a,*], Dadhi Adhikari[b]

[a] New Mexico Consortium, 6721 Academy Rd NE, Suite A, Albuquerque, NM 87109, United States
[b] Department of Economics, University of New Mexico, MSC05 3060 1 UNM, Albuquerque, NM 87131-0001, United States

ARTICLE INFO

Article history:
Received 20 August 2014
Received in revised form 14 March 2016
Accepted 15 March 2016
Available online 7 April 2016

Keywords:
Higher education
Scientists
Government policy
Career choice
Education finance

ABSTRACT

A National Institutes of Health (NIH) taskforce recently recommended decreasing the number of graduate students supported on research assistantships, and instead favoring traineeship and fellowship funding mechanisms. Using instrumental variables estimation with survey data collected from U.S. PhD-granting biomedical sciences departments and their newly-minted PhDs, we find that increases in these programs' NIH-funded traineeships and fellowships do significantly increase programs' total graduate enrollments, particularly of female students. However, PhDs who were funded primarily as research assistants are significantly more likely to take research-focused jobs in the U.S. scientific workforce after they graduate, as compared to PhDs who were primarily supported as trainees or fellows. The suggested policy changes thus may have unintended, negative consequences for scientific workforce participation.

1. Introduction

In FY2012, the U.S. National Institutes of Health (NIH) funded over $30 billion in health-related research, of which $17.3 billion—56%—went to support research at U.S. universities and colleges. The NIH Advisory Committee to the Director (ACD) recently tasked a working group to evaluate and make recommendations to improve the diversity and sustainability of the nation's biomedical research workforce. The ACD working group's final report, posted June 2012, recommends several policy changes, including some that would change how graduate students in biomedical sciences and related fields at U.S. universities are trained and funded. Pickett et al. (2015) reiterated one of these proposals among their eight consensus recommendations, stating: "Institutions and Federal agencies should shift support of trainees toward fellowships and training grants." However, little evidence exists to help us understand how such changes might impact subsequent retention of completed PhDs in the U.S. scientific workforce.

In this paper, we combine survey data gathered from the universe of U.S. degree-granting institutions, from biomedical sciences departments and programs, and from individuals who earned PhDs in those programs, to explore how differences in students' sources and mechanisms of financial support in graduate school may impact their early-career retention in the U.S. scientific workforce. Specifically, we assess whether U.S.-trained PhD students whose primary mechanism of financial support in graduate school was a research assistantship, teaching assistantship, personal or family funds, or some other form of support are more or less likely to transition after graduation into scientific research-focused employment, as compared to students graduating from those programs who were supported primarily as trainees or fellows.

Our paper builds on and extends prior studies in several ways. First, in contrast with prior studies that have examined overall stay rates for foreign students graduating from U.S. higher education institutions, in this article we consider more specifically new PhDs' retention in the U.S. scientific workforce—that is, not only whether PhDs stay in the U.S., but also whether they choose jobs where their primary work activity is basic or applied research and/or development after completion of their PhDs. We also expand the scope and population of interest for this question beyond foreign students on temporary resident visas, to consider and compare postdoctoral employment outcomes for U.S. citizens and permanent residents as a function of their graduate school funding mechanisms, as well.

Second, to better inform NIH policy with respect to the ACD recommendations, we focus on graduate training and workforce outcomes within biological and biomedical sciences, which have had relatively lower penetration by foreign PhD students as compared to many other S&E fields. We also explore possible differential effects of graduate student funding mechanisms for U.S. versus foreign students, with particular attention to the role research assistantships may have in encouraging or discouraging completed PhDs from joining the U.S. scientific workforce.

Finally, our empirical models account for possible bias that could arise due to unobserved university-, program-, or student-level characteristics. For example, if higher-ability students are more

* Corresponding author.
E-mail addresses: meg@newmexicoconsortium.org, meg@mbkanalytics.com (M.E. Blume-Kohout), dadhinp@unm.edu (D. Adhikari).

http://dx.doi.org/10.1016/j.respol.2016.03.011

likely to receive fellowship funding, to desire research-focused jobs, and to obtain their preferred type of employment upon graduation, or alternatively if some institutions that attract higher levels of R&D funding over time have both a greater share of students supported as RAs and better career placement assistance for their graduates, such correlations could cause us erroneously to conclude some mechanisms of support are more effective than others at promoting new PhDs' transitions into the U.S. scientific workforce. We account for these possibilities in our empirical models of PhD student outcomes first through inclusion of university and PhD major field fixed effects, then by using two-stage instrumental variables estimation.

2. Background

Doctoral students' enrollment, retention, and timely completion of degrees have all previously been shown responsive to availability of financial support (Blume-Kohout and Clack, 2013; Freeman et al., 2009). However, financial support for any given graduate student enrolled at a U.S. university can be—and often is—provided via multiple different mechanisms. Fellowships typically differ from other types of student assistantships in covering tuition and providing some stipend support, without expectation of services to be performed or subsequent repayment. In our data, among the 35% of U.S.-trained biomedical sciences PhDs who said their primary source of support was a fellowship or traineeship, 27% reported no other external source of funding, and 45% held neither a research assistantship nor a teaching assistantship.

By contrast, research assistantships are typically funded by faculty members' externally-sponsored research project grants, with salary and other benefits (e.g., tuition waiver, health insurance, etc.) provided in return for work performed. Although over half (58%) of U.S.-trained biomedical sciences PhDs graduating between 2000 and 2010 report having held a research assistantship at some point in graduate school, as shown in Table 1 only 31% identified this mechanism as their primary source of support.

While the tuition benefits and take-home salaries that research assistants (RAs) and fellows receive might ultimately provide graduate students with a similar level of financial subsidy, the incentives that each of these mechanisms creates for faculty interaction and the resulting qualitative experiences of students may strongly differ. For example, RAs typically gain exposure through their work to well-designed projects focused on significant research problems, and benefit from greater direct supervision and interaction with one or more senior researchers (Worthen and Gardner, 1988). Doctoral students funded as RAs are more likely to contribute to publishing research articles before graduation, as compared to students relying on other sources of funding (Buchmueller et al., 1999; Millett and Nettles, 2006). Research publication productivity among doctoral students has also long been promoted as an indicator of students' professional development and socialization (Harnett and Willingham, 1979).

As Millett and Nettles (2006) discuss, RAs who work with faculty on externally sponsored research projects may attract greater hands-on involvement and training from faculty members, as the latter's professional success and subsequent funding streams will depend on their productive use of current financial resources. The faculty member thus has direct incentive to train and actively manage his or her RAs, and to have them participate in production of scientific publications. In addition to the structured development of knowledge and skills the RA's on-the-job training provides, the role-modeling provided by the faculty member over the course of the project may also enhance students' progress towards self-efficacy (O'Meara et al., 2014). RAs may also benefit from greater professional socialization and relatedly achieve a greater sense of self-efficacy with regard to prospective scientific workforce employment. By contrast, the relatively greater independence a fellowship affords could leave a student more room to flounder.

The ACD report recommends that NIH shift its support for graduate student training to place greater emphasis on its existing traineeship and fellowship mechanisms, and reduce reliance (and total NIH expenditures) on graduate student RA positions (Tilghman et al., 2012; Pickett et al., 2015). This idea has been raised before: over a decade ago, the National Research Council (2000) made the same recommendation. For students, one presumed advantage of this shift is attenuation of the positive feedback loop between universities' total research funding and graduate student enrollments (Blume-Kohout and Clack, 2013; Stephan, 2012). NIH-funded traineeships and fellowships also may allow greater agency oversight, for example due to the formal mentoring plans required for student trainees. Students with well-developed research agendas may especially benefit from the protected time these mechanisms provide to focus exclusively on their own dissertation research, potentially facilitating more timely degree completion.

Interviews with graduate student recipients of NIH-funded traineeships and fellowships show that being able to focus attention on their studies or dissertation research is the most widely valued aspect of these mechanisms of support (National Research Council, 2005). However, the same study also revealed that deficiencies in mentoring were second only to low stipend levels among students' stated concerns, and the study further noted that traineeship and fellowship awards do not include financial compensation for faculty mentoring activities. Thus, while faculty PIs seem to have direct incentives to expend effort on training the graduate student RAs they employ into productive members of their research teams, there may be relatively little comparable extrinsic incentive for faculty members to invest their time in mentoring students who are supported on traineeships and fellowships.

Finally, NIH's traineeships and fellowships are currently limited to U.S. citizens and legal permanent residents—students who are more likely, overall, to remain in the U.S. after graduation than those on foreign temporary resident visas. From a policy perspective, putting greater emphasis on traineeship and fellowship mechanisms (along with increasing programs' stipend levels) might encourage more U.S. students to pursue doctorates in biomedical sciences, improving long-run sustainability of the U.S. biomedical sciences research workforce (Freeman et al., 2009; Grogger and Hanson 2013, 2015). Conversely, decreasing the availability of RA positions on faculty investigators' research project grants might discourage U.S. departments from admitting foreign students, or discourage admitted foreign students from enrolling, due to foreign students' having fewer alternatives for mentored research training and financial support. Supporting this notion, across our panel of 121 U.S. universities that grant PhDs in biomedical sciences and related fields, we find that an increase in a graduate program's share of students supported as RAs is significantly and positively correlated with higher proportional enrollments of foreign temporary residents. It is not clear, a priori, whether declining federal support would be offset by any increase in institutional funds for foreign students in these fields.[1]

2.1. Funding mechanisms and postdoctoral career choices

Remarkably little evidence exists on factors affecting new PhDs' choice to pursue research-oriented scientific careers. Sauermann and Roach (2012) report that more than 1 in 5 late-stage biol-

[1] In this context, institutional funds include public funds from state government, as well as philanthropic and corporate donations.