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Symptoms versus Root Causes: A Needed Structural Shift in Academia to Help Early Careers

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Early career scientists in most fields—especially in biomedical sciences—are facing major challenges: The average age of first time NIH grant recipients is rising; many early career scientists spend 3 or more years in low-paid and overworked temporary postdoc positions; thousands interested in academia may never land academic positions; and serious mental health issues challenge many graduate students (Alberts et al. 2014, Levecque et al. 2017, Andalib et al. 2018). Various ameliorative policies have been suggested. In a recent article in *BioScience*, Beans (2018) emphasized the importance of broadening PhD education and discussing career options outside of academia in order to train and attract students for nonacademic jobs—points that many other scholars in biomedical and life sciences have made (e.g., Fenster and Dudash 2018). In a recent NASEM report (2018), seven corrective policy initiatives were offered, including capping postdoctoral positions at 3 years, supporting permanent research positions with higher pay in academia, requiring projects to support career development of postdocs through allocating specific funding (referred as the *postdoc tax*), and—increasing federal funding. There are some valuable arguments in this report, but none appears to address academic-system structural change. Rather, the main focus is on tinkering with policies related to the population of newly minted PhDs.

In an alternative approach, the underlying complexity of the entire education and workforce system should be examined. It is true that the immediate problem with the overproduction of early career scientists is that there are too many PhD students exiting colleges and universities. But there is a second and equally perplexing problem at the opposite end of careers: the fact that too many researchers either never retire or only leave at the end of a career of 40 or more years. Regarding the PhD creation rate, now, there are enough studies that show only a small fraction of PhD students (e.g., in biomedical science, only 16%) land tenure-track positions (Larson et al. 2014, Ghaffarzadegan et al. 2015). Of course, some PhD students are not interested in those positions (Beans 2018, Fenster and Dudash 2018), but still, the success ratio is surprisingly small. Rarely does one quantify what is happening for the other 84% of biomedical science PhDs who mostly work in industry. Was it really necessary to get a PhD degree? Policy reports only infrequently examine whether and how we should shrink PhD programs. Universities reward professors who graduate more PhD students. There is an unspoken mantra here: "More is better."

Regarding retirement, tenured professors once had to leave tenure status at age 65, but no longer, as there is no upper age limit for retiring. Not unexpectedly, established professors now tend to stay longer in tenured positions (Blau and Weinberg 2017). Let's do a thought experiment: Assume that there are 20,000 tenure-track faculty positions and that the average faculty career duration is 20 years (because of not getting tenure and other issues, not all faculty members remain until retirement). In our thought experiment, every year, about 1000 professors exit faculty positions, and 1000 new professors replace them. If the average career duration of 20 years suddenly changes to 25 years, the exit rate will drop to 20,000/25 = 800, implying an equally reduced hiring rate of 800. That is a 20-percent decline in the hiring rate. This simple, back-of-the-envelope calculation is amazingly very close to what has happened. Larson and Gomez Diaz (2012) estimated a 19% decline in tenure-track openings in MIT as a result of the removal of the fixed-age mandatory retirement.

Given the two key systems phenomena—a high PhD creation rate and the longer academic lives of faculty members, the simple physical rule of mass conservation provides insight into the problem of early career scientists: When the inflow of PhDs wanting faculty positions is more than the outflow of faculty members from tenure-track positions, the population of early career scientists in temporary positions increases. Where else are they to go? But most reports appear to neglect these important issues. They hardly question the assumption that "more is better" for the number of PhD students and for research funding. The focus is often not on the size of programs, the PhD inflow rate, and faculty outflow rate but more on fixing the symptoms. The large and growing postdoctoral population represents a symptom but not the core problem having systemic root causes. The result of a narrow approach would be marginal or even unintended. For example, a policy such as forcing postdocs to leave that status after 3 years may greatly reduce a postdoc's bargaining power in year 3, as the clock is winding down—to say nothing of the mental anguish associated with the prescribed 3-year limit. Such tinkering

does not address fundamental system problems.

We need to move from symptoms to the root causes. The ever-deepening reservoir of postdocs is an expected outcome for a system whose attempted inflow rate far exceeds its outflow rate. Yes, efforts to provide supportive environments and cultures for postdocs are a must, but we strongly suggest addressing the two major systems problems: reducing PhD production rates and incentivizing earlier departures from tenure-track faculty positions. The first objective can be achieved not by fiat but by better market transparency: informing students and their advisers about the realities of data, that faculty career prospects are challenging, and that only a minority of newly minted PhDs successfully land tenure-track positions. More funding to support more PhD students would only work in the opposite direction.

The latter objective of accelerating early retirement can be achieved by financial incentives, as well as designing inviting posttenure positions. As posttenure professors, established faculty members can benefit from significantly lower workloads, can retain authority to undertake research (if they want), and can choose only those activities that they find appealing in their late career. Some may focus on mentoring early career professors. Reducing the lengths of tenure-track faculty careers results in concomitant increases in the number of new faculty slots. By working both ends of the system pipeline at once—inflows and outflows—we may see significant decreases in postdoc populations and increases in new assistant professorships.

Without addressing the root causes, universities will continue exploiting low-paid postdocs to undertake many of the activities previously only associated with faculty members, such as teaching, writing research grants, and writing research papers "coauthored" with the faculty advisors. The current policy focus on symptoms allows universities to slow the flow of their tenure-track faculty ranks while still growing their population of students. Job market prospects in academia will look the same. Consequently, associated pressures and mental health problems will continue to exist. And the problem will persist.

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