Education

Winning a competitive research award decreases time to degree in bioscience PhD programs, but not for everyone

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Abstract

Time to degree completion is an important metric of academic progress and success for doctoral students. It is also a common way for educational stakeholders to compare programs even if the content of the degree programs varies. But what types of behaviors and experiences are associated with faster times to degree? In this education article, we examine the relationship between receiving competitive research awards (e.g. grant writing) and time to degree for Ph.D. students. We organize our analyses by student identities, specifically gender and underrepresented minority (URM) status, to examine differences in time to degree based on student demographics. Our dataset included students that graduated between academic years 2008-09 through 2018-19. Using well known, open access computational tools, we find that URM women who won competitive research awards graduate faster than all other students who also won awards. We also find that URM women and all URM students graduate faster compared to students who did not win awards. Combined, these results show how competitive awards and grants can facilitate faster times to degree for some students. This study suggests similar introspective analyses at other institutions and databases are needed.

Introduction

Writing is, in some ways, the most essential skill that students develop and fine tune during their time in PhD programs. Scientific communication is strongly linked to academic success including research career persistence (1). Although most of the attention on academic writing is centered on publications and presentations, grant writing is important for bioscience doctoral students because it provides them an opportunity to demonstrate their ability to think and act like a scientist by developing an original research project (2). And because science is so dependent on one's ability to secure external funding, grants are a critical academic currency. Aside from the financial benefits of securing grants, grant writing builds skills like critical thinking and successful communication of scientific ideas (3)(4). Grant writing is also essential for advancement at the faculty level and securing grants improves one's chances of advancing to tenure (5)(6)(7)(8). While the links between faculty career success and grant writing is evident, the relationship between PhD student success and grant writing is less understood.

There are many different markers for success as a PhD student, but degree completion is a significant one (9). The time it takes to complete a degree can relate to delayed career earnings, use of institutional resources, and differing amounts of student debt (e.g. accrued interest on student loans). In this way, a student's time to degree, measured by the number of active graduate quarters (or semesters) until PhD conferral, is a significant commitment for students as they develop professionally and is also important to the institutions that support them. It is also a metric used by doctorate granting universities to compare outcomes (10). Therefore, if faculty success is strongly associated with winning grants, how might winning grants be associated with PhD student success in terms of time to degree? Some data indicates that submitting or receiving external funding impacts time to degree (11), but no formal data has yet been collected or

analyzed to support this specifically for the biosciences. To bridge this gap, this study assessed the impact of external funding on time to degree for doctoral students studying the biosciences at Stanford University.

Doctoral experiences, like all social experiences, are shaped by one's personal identity in ways that reflect patterns of inequity in STEM (12)(13)(14)(15)(16)(17). Student diversity based on race and gender is important for inclusion and representation, but determining factors associated with their success is also important. In some cases, student diversity and identity have been sources of intellectual innovation despite these same students receiving less recognition (18). Other studies have observed that STEM students from minoritized backgrounds are also less likely to feel senses of belonging in ways that are associated with positive academic outcomes (19)(20)(21) and negative mental health symptoms (22)(23). Given the stakes and prior research, our paper weaves these different threads together using statistical and computational tools on institutional data to answer the question about the relationship between securing external funding and time to degree while also tending to whether student identities are salient in these relationships.

Our paper answers the following questions about the nature of the relationship between time to degree, student identity, and winning competitive grants and fellowships:

- What is the relationship between time to degree and winning competitive awards for students in the biosciences?
- How is this relationship mediated by student identity, specifically race and gender?
- How can computational tools used for research be adapted for introspective analysis of our institutions?

We find that winning competitive awards is associated with a shorter time to degree but only for specific groups of students. These findings, which we describe in more detail below, show how an important aspect of professional success among faculty (e.g. grant writing) is also correlated with how long it takes for students to complete their programs.

Materials and Methods

Our data were pulled from several data sources, queried in September 2022. We leveraged the Stanford Electronic Research Administration System (SeRa), a database which tracks external proposals, such as fellowships or grants, submitted and awarded to grant seekers at Stanford (including doctoral students); see (24) for more information about the database. We also considered other fellowships that are not tracked by SeRa but are popular among students at Stanford (e.g. National Sciences Foundation (NSF) Graduate Research Fellowship, Ford Fellowship, Soros Fellowship, National Defense Sciences and Engineering Graduate (NDSEG) Fellowship). The publicly available NSF Graduate Research Fellowship Program (GRFP) Award Offers and Honorable Mentions List (see https://www.research.gov/grfp/) provided names of graduate students that won the NSF GRFP Award and Honorable Mentions status. The Ford Foundation Predoctoral Fellowship also posts the names of recipients (see Ford Fellows directory). Fellowships not based directly on research (Soros Fellowship) and with limited publicly available information (NDSEG Fellowship) were excluded. We wanted to provide this additional detail to encourage other researchers interested in replicating this study. Funding sources included the National Institutes of Health (NIH), the Howard Hughes Medical Institute, and more specialized sources such as the American Brain Tumor Association. Finally, we used

Stanford's Student Integrated Reporting and Information System (SIRIS) to query official university enrollment records related to time-to-degree and student demographics.

To study the relationships between time to degree and funding acquisition, we considered the students' gender and URM status. We defined URM using federal categories mandated by the Department of Education; this is also how large organizations like NIH define URM status. The URM category includes students who are US citizens or permanent residents and who self-identify as American Indian/Alaska Native, Black/African American, Hispanic/Latino, or Native Hawaiian/Other Pacific Islander. The category includes any student who affiliates, with any one of these categories, regardless of whether they also affiliate with other categories (i.e., affiliating as "White" and "Black/African American" yields a URM designation). We excluded students who transferred into the program or discontinued before graduating (n = 12). Medical Scientist Training Program (MSTP) students were not included in our analyses. See Table 1 for a breakdown of the data. We do not know how many of the students in our sample applied to the NSF GRFP, but 140 students applied for external funding and of those students 59 won awards (data not shown).

Table 1: Overview of data.

Variable	**Count**
Total number of students[1,2,3]	789
Students who received funding[1,2]	91 (11 SeRa, 78 NSF, 4 Ford Predoctoral)
URM Status[3]	103 (23 funded)
Gender[3] (Only options were Male/Female)	405 Female (62 funded) 384 Male (29 funded)

Academic graduation year[3]	2008-09 through 2018-19
Programs[3] (all programs had at least one student secure funding)	Biochemistry Biology Biomedical Informatics Biophysics Cancer biology Chemical and Systems Biology Developmental Biology Genetics Immunology Microbiology and Immunology Molecular & Cellular Phys Neuroscience Stem Cell Bio Regenerative Med Structural Biology

1: NSF; 2: SeRa; 3: SIRIS

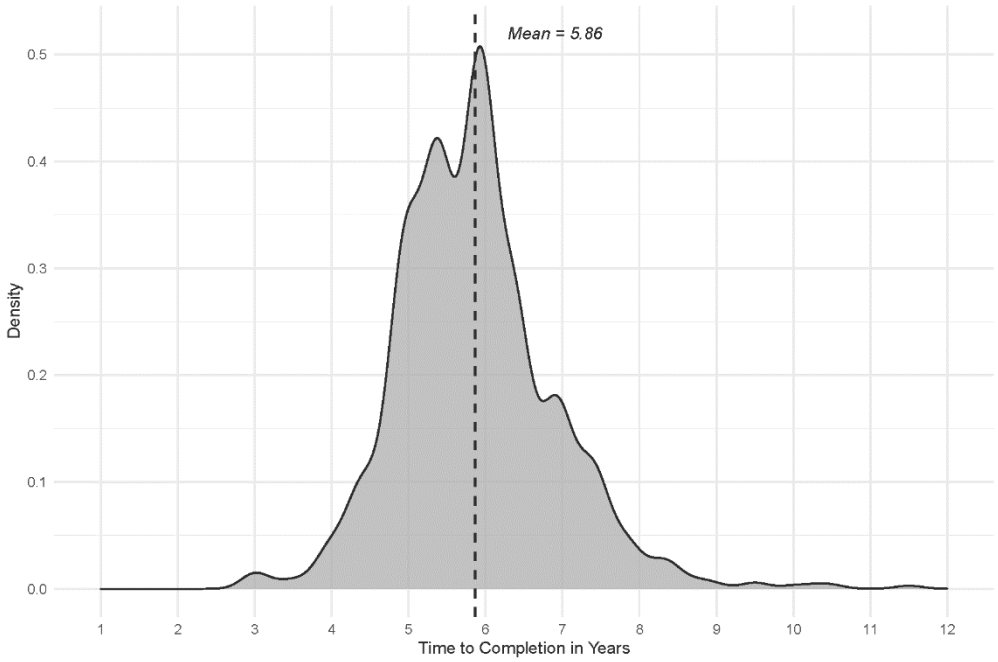
We used Welch's t-test to compare group means while accounting for different group sizes. To visualize the key findings and results, we used tools from ggplot2 (25). The outcome of interest that we compared is the elapsed time to degree measured in years. We grouped the students by URM status, gender, and the intersections of URM status and gender. Although we tested many different groups, we do not present results for every single statistical test for succinctness and to focus on our key findings with the strongest, most defensible results.

Our purpose for selecting the specific R package ggplot2 was to most clearly and simply communicate our primary findings (26). The package streamlines the task of creating figures that are easily interpretable, reproducible, and well documented. Additionally, its connection to the tidyverse (27) makes it easy to write code that first cleans the data and then generates data visualizations. Though there are many other visualization tools to consider (including those available in Python), ggplot2 only requires a few lines of code to generate figures that experts and non-experts can easily interpret. We encourage other researchers to utilize these well-known computational methods to analyze student progress data in their departments and institutions.

Results

Among all students in the dataset, the average time to degree was 5.86 years; the median time was 5.80 years; and the range was 3.0 to 11.5 years. See Figure 1 for a density plot of the years to degree. Although the range is wide, 68% of the PhD students in our data completed their programs in six or fewer years, similar to (though higher than) a national study of bioscience PhD students that reported 49% of students complete their degrees in 6 or fewer years (28). Next, we compared average times to degrees for different groups of students and used ggplot2 to visualize variation in our data with respect to student identity. The first three analyses do not include the four Ford Predoctoral Fellowship winners in the “winner” groupings. The Ford Predoctoral winners had a higher average time to degree than other students (6.80 years) and, unlike the other funding programs considered, the program specifically targets underrepresented minorities in academia.

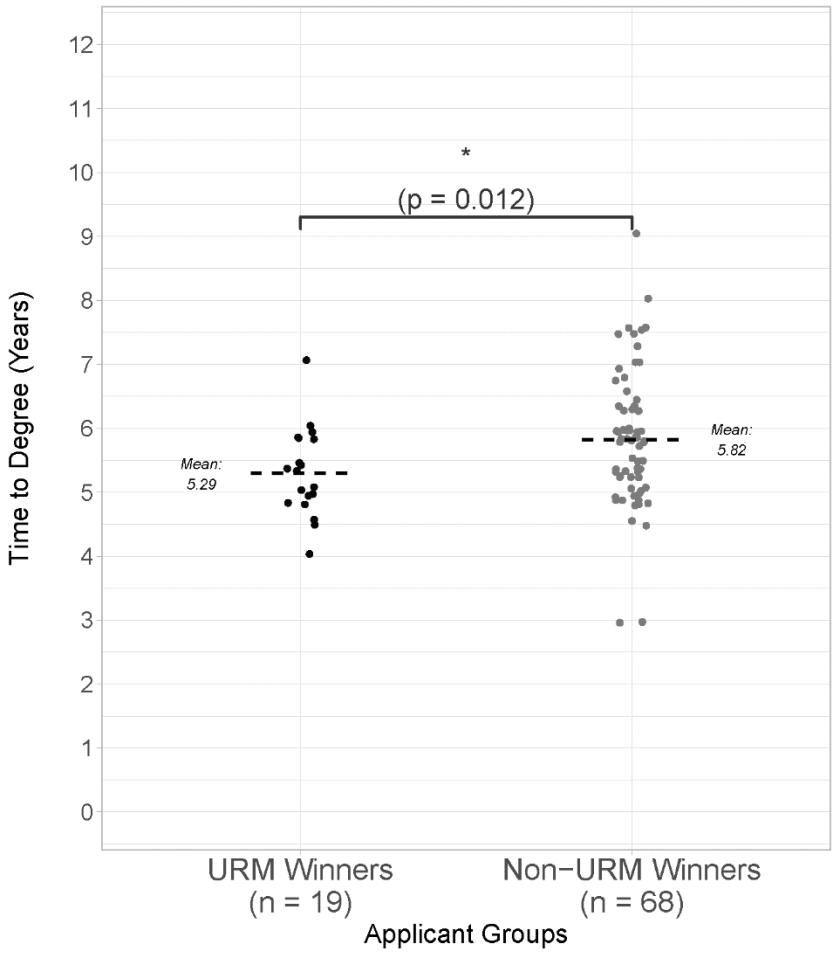
Figure 1: Density plot for years to degree, including the mean time to degree (5.86 years). The median time to degree (5.80 years) is not included to make the figure easier to interpret.



Our initial comparisons were based on student gender, using sex as a surrogate, or URM status. In our data, students could only select Male or Female. To be inclusive and accurately represent the distinction between sex and gender, future studies might consider non-binary students, but this is a limitation of our analysis on student gender. None of the comparisons we tested based on student gender and winning grants were statistically significantly different. For example, there was no significant difference between women who won grants compared to women who did not (5.90 years and 5.84 years on average respectively; data not shown), nor was there a difference between men who won grants and women who won grants (5.71 years and 5.90 years on average respectively; data not shown). This was not the case for student URM status, however. URM students who won grants tended to graduate faster than other students,

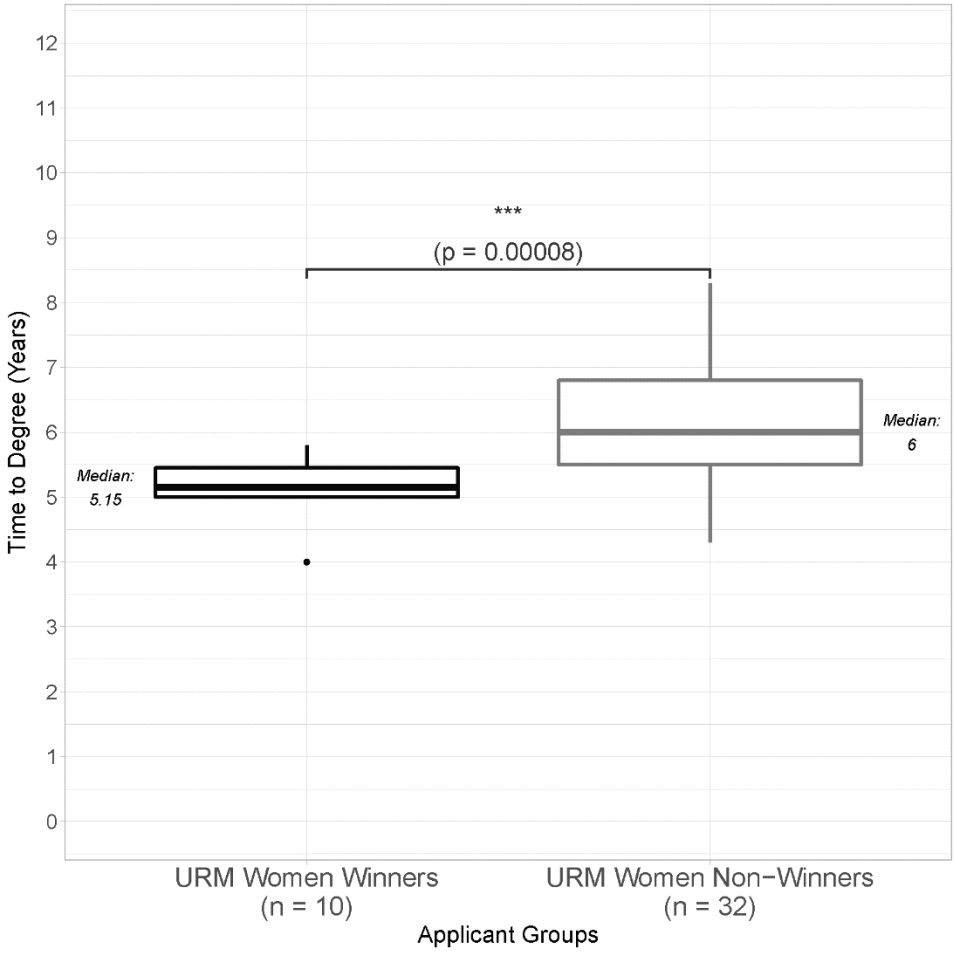
including non-URM students who also won grants (Figure 2). They also graduated faster than URM students who did not win grants (5.56 years and 5.92 years on average respectively, p value = 0.02). The figures include indicators of statistical significance, with one asterisk indicating p-values below 0.05; two asterisks for p-values below 0.01; and three asterisks for p-values below 0.001. Any references to statistical significance also follow these conventions.

Figure 2: URM students who won grants (black dots) graduated faster than non-URM students who won grants (gray dots). The mean time to degree for each group is indicated by the dashed lines and the p-value is indicated by the asterisk at the top of the figure (p < 0.05).



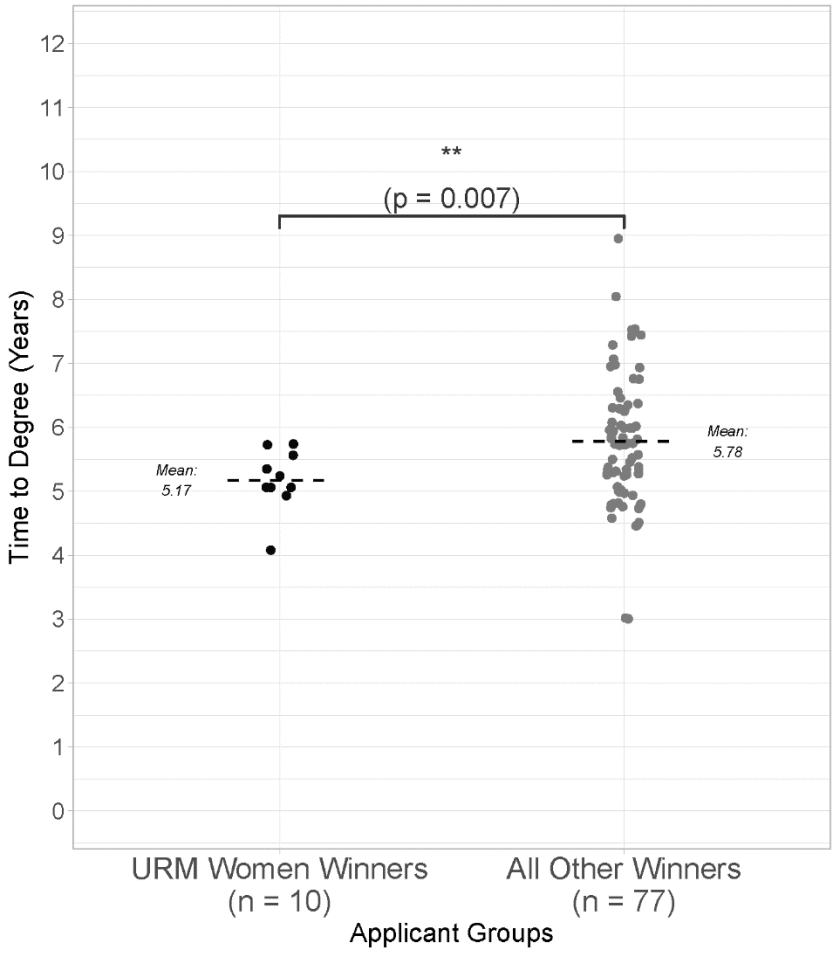
Although gender in isolation was not strongly associated with faster or slower degree completion times, the intersection of URM status and gender did show a strong association. URM women who won grants graduate significantly faster than URM women who did not receive grants (5.15 years and 6.00 years median respectively, p value = 0.00008). Figure 3 shows a boxplot in which the fastest quartile of URM women who did not win grants graduated at around the same time as the slowest quartile among URM women who won grants. This result is also noteworthy when compared to average time to degree (5.86 years; Figure 1) for all the students in the dataset. URM women who receive grants graduate faster on average than all students by slightly less than half a year, and conversely URM women who do not receive grants graduate slower than average by approximately half a year.

Figure 3: Boxplot showing that URM women who win grants (black) graduate nearly one year faster on average than URM women who do not win grants (gray). The p-value is indicated by the asterisk at the top of the figure ($p < 0.001$)



URM women graduated faster when compared to all other students who won grants as well ($p < 0.01$), suggesting that winning grants might play a particular facilitative role in URM women graduating faster (Figure 4). While we do not make any causal claims in this paper, this finding highlights the importance of intersectional research on doctoral student experiences and points to a potentially strong relationship between academic progress and winning competitive research awards. This insight could be particularly useful for mentors and advisors of women and URM students (and URM women) in STEM fields. Combined, these results show significant differences in time to degree for specific groups or subsets of students who win competitive awards.

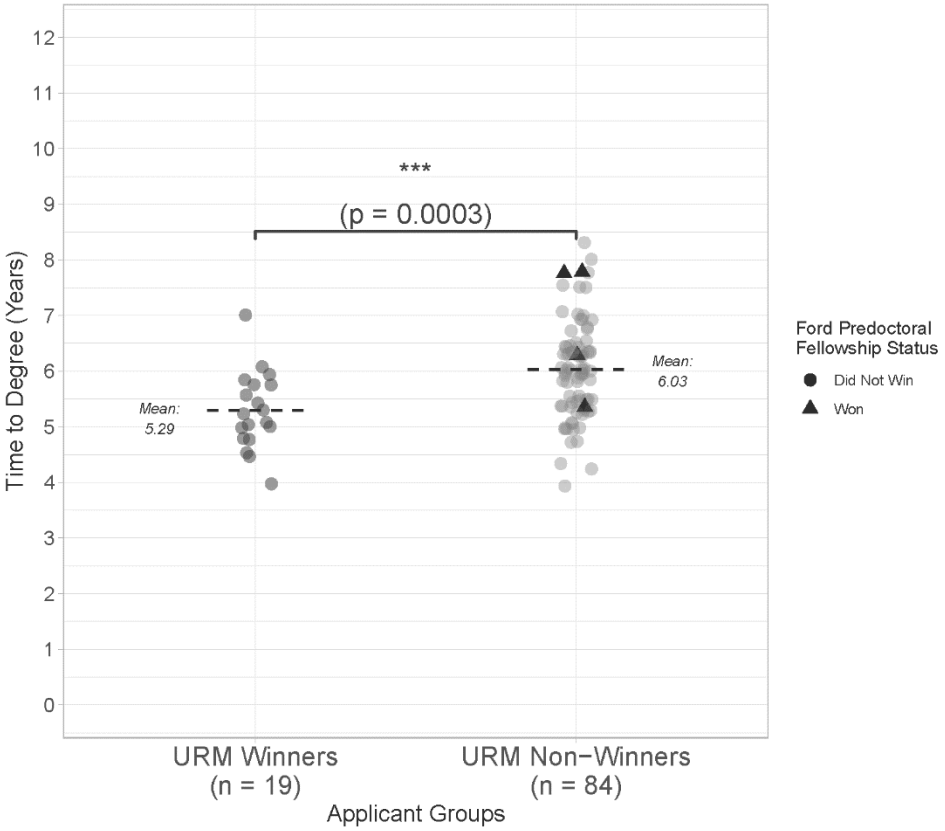
Figure 4: URM women who won grants (black dots) graduated faster than all other students who won grants (gray dots). The mean time to degree for each group is indicated by the dashed lines and the p-value is indicated by the asterisk at the top of the figure (p < 0.01).



Finally, we compare URM winners and URM non-winners. We find URM winners graduated a full academic year (0.74 calendar years or about 9 months) faster on average than URM non-winners (Figure 5). Next, we asked if the Ford Fellowship, given its unique

expectations on “sustained personal engagement with communities that are underrepresented in the academy” (29), impacted awardee’s time to degree. In our data set, the four students who won the Ford Fellowship did not also win NSF or SeRa-tracked funding, thus we included them within the URM non-winner group (see dark gray triangles). The time to degree for the Ford Fellows ran counter to the other trends we found by taking an average of 6.80 years to complete their PhD. This was also on average 0.77 years (a full academic year) longer than URM non-winners and 1.51 years (more than two academic years) longer than URM winners (Figure 5). These results show a strong relationship with time to degree and winning competitive awards but in the opposite direction for the Ford Fellowship: longer as opposed to shorter average times to degree. A significant aspect to participation in the Ford programs is service and volunteering, and the longer time to degree for these students might reflect the realities of trying to balance the work of advancing in a doctoral program with competing service goals. Although the Ford Foundation is ending their doctoral fellowship programs, this finding highlights that the relation between time to degree and winning competitive awards might not be purely transactional but also dependent on the nature and expectations that come attached to the funding.

Figure 5: URM students who won grants (left) graduated faster than URM students who did not win grants (right). The Ford Fellowship winners (triangles) did not also win NSF or SeRa-tracked funding, thus were included within the URM non-winner group. The mean time to degree for each group is indicated by the dashed lines and the p-value is indicated by the asterisk at the top of the figure ($p < 0.001$).



Discussion and Future Directions

Using well-known and accessible statistical (t-tests) and computational (ggplot2) tools, we found that faster times to degree are associated with winning competitive grants, but only for specific groups of students, including URM students and URM women. We found, URM students who won research awards graduated faster than non-URM students who also won research awards. Likewise, we found that URM winners graduated faster than URM non-winners, though Ford Fellowship winners did not follow this trend. Significantly, URM women who receive grants graduated faster on average by about half a year than all students. And arguably more important, we find a negative impact on URM women non-winners represented by an increase in time to

degree. When it comes to winning competitive research awards, the stakes are higher for URM women because when URM women won awards, they graduated about a year faster, but when they did not win awards, they graduated about half a year slower and these findings did not hold true to the other identity groups measured.

Since many students are never formally trained in how to write proposals for competitive awards despite the practical benefits (30–32), these results point to practical ways to streamline the student experience by providing grant writing training (24). This could also extend other research and practice on the positive relationship between specific graduate experiences and career trajectories (33). The computational tools and frameworks which guided our analysis could also be used to compare the patterns in our dataset with other data across systems and organizations to improve educational outcomes and programming.

While we do not make any causal claims about the relationship between winning competitive awards and time to degree, there are nevertheless important implications to consider for doctoral students in the biosciences. For URM and URM women students, the strength of the relationship between time to degree and awards could point to several different factors. It is possible that winning competitive awards serves as a strong validation of their research goals and interests, and scientific identity (17), which may directly influence persistence in the sciences (34). Studies have supported this by describing how URM and URM women grant seekers propose research that directly addresses community needs (35). However, the trend with the Ford winners shows that service and community engagement might delay times to degree. This delay is consistent with a common and well-studied phenomena often referred to as a *cultural tax*, *minority tax*, or *invisible labor*. This *tax*, while valuable to institutions, negatively impacts academic progress for individuals from marginalized identity groups (36–39).

Although there are other metrics for academic success for students, the fact that time to degree is strongly associated with winning competitive grants for these students could help departments and institutions reconsider how they measure success and who benefits most from current metrics. Future studies could take a deeper dive into these relationships and even analyze the types of grants that students are writing and submitting. Other follow-up studies may include tracking students who win competitive awards beyond their PhD to see if there is variation in career outcomes and filter the data and analysis by URM status and gender. Although this paper focuses on academic careers, it is likely that developing grant writing skills has tangible benefits for non-academic careers as well. Because obtaining a first grant is associated with successfully acquiring future grants, an example of an academic Matthew effect (40), it would be interesting to investigate if grant writing successes as a graduate student correlate with future successes at the faculty stage. The statistical and computational tools we utilized could be adapted for these analyses.

The ease with which these figures were generated, and their potential use outside of purely academic research shows one way that computational researchers could participate in institutional analysis and improvement. This work could become integral to other activities intended to improve educational experiences and outcomes for computational bioscientists (41,42). If the patterns we describe in our dataset mirror patterns at other schools, these findings could be important information that the entire discipline should consider and address (10). Beyond comparing data and patterns within them, future studies could also test different data visualization tools (e.g. Seaborn for Python) or create interactive data dashboards to disseminate broadly. This work would be of interest to fellow researchers but also to other educational stakeholders. Writing grants and other competitive awards is a key part to success in the

academy, and our paper shows which students benefit most from this form of success and should encourage programs to invest in grant writing.

Considering the professional benefits of grant writing and our analysis showing its relationship with time to degree, we encourage URM and especially URM women to pursue competitive awards. Of course, grant writing entails not just the act of writing a proposal but the entire process of designing a project and executing a research plan. Graduate students who have these types of experiences graduate faster, making grant writing an important skill to develop earlier rather than later. Therefore, it is important for advisors to be informed about the impact grant writing (and other skills often deemed as ‘peripheral’ for bioscience PhD students) may have on time to degree in order to provide advisee-specific advice that will advance their training and development into an independent and successful scientist.

References

1. Cameron C, Lee HY, Anderson CB, Trachtenberg J, Chang S. The role of scientific communication in predicting science identity and research career intention. Sugimoto CR, editor. PLoS ONE. 2020 Feb 19;15(2):e0228197.

2. Files DC, Hume PS, Krall J, Montemayor K, Schmidt EP, King LS. Grant Writing for Clinicians in Training. Chest. 2020 Apr;157(4):932–5.

3. Quitadamo IJ, Kurtz MJ. Learning to Improve: Using Writing to Increase Critical Thinking Performance in General Education Biology. Kincaid WB, editor. LSE. 2007 Jun;6(2):140–54.

4. Kahn R, Conn G, Pavlath G, Corbett AH. Use of a grant writing class in training PhD students. Traffic. 2016 Apr 6;17(7).

5. Bloch C, Graversen EK, Pedersen HS. Competitive Research Grants and Their Impact on Career Performance. Minerva. 2014 Mar;52(1):77–96.

6. Smith JL, Stoop C, Young M, Belou R, Held S. Grant-Writing Bootcamp: An Intervention to Enhance the Research Capacity of Academic Women in STEM. BioScience. 2017 Jul 1;67(7):638–45.

7. Thorpe, Jr RJ, Vishwanatha JK, Harwood EM, Krug EL, Unold T, Eide Boman K, et al. The Impact of Grantsmanship Self-Efficacy on Early Stage Investigators of The National Research Mentoring Network Steps Toward Academic Research (NRMN STAR). Ethn Dis. 2020 Jan 16;30(1):75–82.

8. Ransdell L, Lane T, Schwartz A, Wayment H, Baldwin J. Mentoring New and Early-Stage Investigators and Underrepresented Minority Faculty for Research Success in Health-Related Fields: An Integrative Literature Review (2010–2020). IJERPH. 2021 Jan 7;18(2):432.

9. de Valero YF. Departmental Factors Affecting Time-to-Degree and Completion Rates of Doctoral Students at One Land-Grant Research Institution. The Journal of Higher Education. 2001 May;72(3):341–67.

10. Blank R, Daniels RJ, Gilliland G, Gutmann A, Hawgood S, Hrabowski FA, et al. A new data effort to inform career choices in biomedicine. Science. 2017 Dec 15;358(6369):1388–9.

11. Ehrenberg RG, Mavros PG. Do Doctoral Students' Financial Support Patterns Affect Their Times-To-Degree and Completion Probabilities? The Journal of Human Resources. 1995;30(3):581.

12. Bernard RE, Cooperdock EHG. No progress on diversity in 40 years. Nature Geosci. 2018 May;11(5):292–5.

13. Chaudhary VB, Berhe AA. Ten simple rules for building an antiracist lab. Schwartz R, editor. PLoS Comput Biol. 2020 Oct 1;16(10):e1008210.

14. Palmer R, Maramba D, Dancy II T. A qualitative investigation of factors promoting the retention and persistence of students of color in STEM. Journal of Negro Education. 2011;80(4):491–504.

15. McCoy DL, Luedke CL, Winkle-Wagner R. Encouraged or Weeded Out: Perspectives of Students of Color in the STEM Disciplines on Faculty Interactions. Journal of College Student Development. 2017;58(5):657–73.

16. Master A, Meltzoff AN. Cultural Stereotypes and Sense of Belonging Contribute to Gender Gaps in STEM. International Journal of Gender, Science and Technology. 2020 Apr;12(1):152–98.

17. Committee on Effective Mentoring in STEMM, Board on Higher Education and Workforce, Policy and Global Affairs, National Academies of Sciences, Engineering, and Medicine. The Science of Effective Mentorship in STEMM [Internet]. Byars-Winston A, Dahlberg ML, editors. Washington, D.C.: National Academies Press; 2019 [cited 2022 May 11]. Available from: https://www.nap.edu/catalog/25568

18. Hofstra B, Kulkarni VV, Munoz-Najar Galvez S, He B, Jurafsky D, McFarland DA. The Diversity–Innovation Paradox in Science. Proc Natl Acad Sci USA. 2020 Apr 28;117(17):9284–91.

19. Walton GM, Cohen GL. A question of belonging: Race, social fit, and achievement. Journal of Personality and Social Psychology. 2007;92(1):82–96.

20. Walton GM, Cohen GL. A Brief Social-Belonging Intervention Improves Academic and Health Outcomes of Minority Students. Science. 2011 Mar 18;331(6023):1447–51.

21. Walton GM, Cohen GL, Cwir D, Spencer SJ. Mere belonging: The power of social connections. Journal of Personality and Social Psychology. 2012;102(3):513–32.

22. Strayhorn TL. College students' sense of belonging: a key to educational success for all students. Second edition. New York: Routledge; 2019.

23. Sargent J, Williams RA, Hagerty B, Lynch-Sauer J, Hoyle K. Sense of Belonging as a Buffer Against Depressive Symptoms. J Am Psychiatr Nurses Assoc. 2002 Aug;8(4):120–9.

24. Botham CM, Brawn S, Steele L, Barrón CB, Kleppner SR, Herschlag D. Biosciences Proposal Bootcamp: Structured peer and faculty feedback improves trainees' proposals and grantsmanship self-efficacy. Cameron C, editor. PLoS ONE. 2020 Dec 28;15(12):e0243973.

25. Wickham H. Data Analysis. In: ggplot2 [Internet]. Cham: Springer International Publishing; 2016 [cited 2022 Oct 24]. p. 189–201. (Use R!). Available from: http://link.springer.com/10.1007/978-3-319-24277-4_9

26. Wendt CJ, Anderson GB. Ten simple rules for finding and selecting R packages. Markel S, editor. PLoS Comput Biol. 2022 Mar 24;18(3):e1009884.

27. Wickham H, Averick M, Bryan J, Chang W, McGowan L, François R, et al. Welcome to the Tidyverse. JOSS. 2019 Nov 21;4(43):1686.

28. Ostriker J, Holland P, Kuh CV, Voytuk JA. A Data-Based Assessment of Research-Doctorate Programs in the United States [Internet]. 2010. Available from: http://www.nap.edu/catalog/12850.html

29. PREDOCTORAL FACT SHEET [Internet]. The National Academies of Sciences, Engineering, and Medicine. [cited 2023 Jan 12]. Available from: https://sites.nationalacademies.org/PGA/FordFellowships/PGA_047958

30. von Hippel T, von Hippel C. To Apply or Not to Apply: A Survey Analysis of Grant Writing Costs and Benefits. Amaral LAN, editor. PLoS ONE. 2015 Mar 4;10(3):e0118494.

31. Kulage KM, Stone PW, Smaldone AM. Supporting dissertation work through a nursing PhD program federal grant writing workshop. Journal of Professional Nursing. 2020 Mar;36(2):29–38.

32. Mackert M, Donovan EE, Bernhardt JM. Applied Grant Writing Training for Future Health Communication Researchers: The Health Communication Scholars Program. Health Communication. 2017 Feb;32(2):247–52.

33. Brazas MD, Ouellette BFF. Continuing Education Workshops in Bioinformatics Positively Impact Research and Careers. Lewitter F, editor. PLoS Comput Biol. 2016 Jun 9;12(6):e1004916.

34. Estrada M, Woodcock A, Hernandez PR, Schultz PW. Toward a model of social influence that explains minority student integration into the scientific community. Journal of Educational Psychology. 2011 Feb;103(1):206–22.

35. Kolev J, Fuentes-Medel Y, Murray F. Is Blinded Review Enough? How Gendered Outcomes Arise Even Under Anonymous Evaluation [Internet]. Cambridge, MA: National Bureau of Economic Research; 2019 Apr [cited 2022 Oct 24] p. w25759. Report No.: w25759. Available from: http://www.nber.org/papers/w25759.pdf

36. Cleveland DrR, Sailes DrJ, Gilliam DrE, Watts J. A Theoretical Focus on Cultural Taxation: Who Pays for It in Higher Education. ASSRJ [Internet]. 2018 Oct 31 [cited 2023 Jan 12];5(10). Available from: http://scholarpublishing.org/index.php/ASSRJ/article/view/5293

37. Padilla AM. Research news and Comment: Ethnic Minority Scholars; Research, and Mentoring: Current and Future Issues. Educational Researcher. 1994 May;23(4):24–7.

38. Rodríguez JE, Campbell KM, Pololi LH. Addressing disparities in academic medicine: what of the minority tax? BMC Med Educ. 2015 Dec;15(1):6.

39. Reid RA. Retaining Women Faculty: The Problem of Invisible Labor. APSC. 2021 Jul;54(3):504–6.

40. Bol T, de Vaan M, van de Rijt A. The Matthew effect in science funding. Proc Natl Acad Sci USA. 2018 May 8;115(19):4887–90.

41. Atwood TK, Bongcam-Rudloff E, Brazas ME, Corpas M, Gaudet P, Lewitter F, et al. GOBLET: The Global Organisation for Bioinformatics Learning, Education and Training. Welch L, editor. PLoS Comput Biol. 2015 Apr 9;11(4):e1004143.

42. Gurwitz KT, Singh Gaur P, Bellis LJ, Larcombe L, Alloza E, Balint BL, et al. A framework to assess the quality and impact of bioinformatics training across ELIXIR. Ouellette F, editor. PLoS Comput Biol. 2020 Jul 23;16(7):e1007976.