

The Matthew effect in science funding

Thijs Bol^{a,b,1}, Mathijs de Vaan^c, and Arnout van de Rijt^{d,e}

^aDepartment of Sociology, University of Amsterdam, 1000 GG Amsterdam, The Netherlands; ^bAmsterdam Centre for Inequality Studies, University of Amsterdam, 1000 GG Amsterdam, The Netherlands; ^cManagement of Organizations Group, Haas School of Business, University of California, Berkeley, CA 94720; ^dDepartment of Sociology, Utrecht University, 3584 CH Utrecht, The Netherlands; and ^eInstitute for Advanced Computational Science, Stony Brook University, Stony Brook, NY 11794

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A classic thesis is that scientific achievement exhibits a “Matthew effect”: Scientists who have previously been successful are more likely to succeed again, producing increasing distinction. We investigate to what extent the Matthew effect drives the allocation of research funds. To this end, we assembled a dataset containing all review scores and funding decisions of grant proposals submitted by recent PhDs in a €2 billion granting program. Analyses of review scores reveal that early funding success introduces a growing rift, with winners just above the funding threshold accumulating more than twice as much research funding (€180,000) during the following eight years as nonwinners just below it. We find no evidence that winners’ improved funding chances in subsequent competitions are due to achievements enabled by the preceding grant, which suggests that early funding itself is an asset for acquiring later funding. Surprisingly, however, the emergent funding gap is partly created by applicants, who, after failing to win one grant, apply for another grant less often.

Matthew effect | cumulative advantage | science funding | regression discontinuity | sociology of science

Why is academic success so unequally distributed across scientists? The theory of the Matthew effect identifies a self-reinforcing dynamic in academic stratification borne out of the tendency for a scientist’s past success to positively affect success in the future (1). The theory is that, if only one of two equally talented young scholars is given an award, the award-winning scholar will go on to have the more successful career. This happens because the winner enjoys resource and status advantages over the nonwinner (2–4). These advantages cause differences in future success to further grow, setting in motion a cumulative advantage process of increasing distinction (5–10). To the extent that luck plays a role in early academic success (11), the Matthew effect may undermine meritocracy by allowing an initially fortunate scientist’s recognition to self-perpetuate, while an equally talented but initially less fortunate counterpart remains underappreciated (1, 5–7).

An interdisciplinary literature finds patterns in observational data that are mostly consistent with the Matthew effect (7). Empirical testing of the Matthew effect, however, has been hampered by the possibility that observed cumulative differences in achievement are instead the gradual manifestation of unequal academic promise, which can only be imperfectly measured. While an empirical pattern of academic recognition repeatedly going to the same scientists is consistent with the Matthew effect, it is confounded with interpersonal differences in talent or productivity (12–19). Namely, increased differentiation in publication, citation, award, and employment records may point to endogenously emergent inequality (3, 20–25), but can also be interpreted as delayed revelation of variable ability or effort (5, 7, 10, 13). Measures of academic success follow extremely right-skewed distributions (20–22, 26–30), consistent with the Matthew effect thesis, but these may also reflect a convex correspondence between a scientist’s capability and reputation, with only the very best receiving the lion’s share of recognition (5, 7, 8, 10, 18, 19, 31–34).

Our contribution is threefold: First, we address the causal inference problem using a regression-discontinuity approach. Second, we systematically study the Matthew effect in science funding, an important outcome that has received scant attention. And third, we identify a participation mechanism driving the Matthew effect whereby early stage failure inhibits participation in further competition through discouragement and lack of resources.

We argue that the Matthew effect may be particularly dominant in the accumulation of individual research funding. In contrast to scientists judging the quality of research papers, reviewers of grants, especially personal grants, are often explicitly tasked with evaluating the ability and promise of the applicant, using past achievements as criteria. The status mechanism theorized in earlier work, whereby past successes aid quality assessment under uncertainty, should thus be prominent in the allocation of research funds. In addition to status, grants provide a resource that can be invested to improve the quality of subsequent work (1, 24). Studying science funding also enables us to evaluate the proposed participation mechanism, whereby funding success promotes continued participation in future competitions for funding. This mechanism is particularly powerful in the earliest stages of the scientific career, when young scholars make defining career choices that largely depend on their prospects of acquiring permanent university positions. Winning an early grant will motivate scholars to compete for funding again if they suspect that their chances in future competitions have improved as a result.

Significance

Why do scientists with similar backgrounds and abilities often end up achieving very different degrees of success? A classic explanation is that academic achievement exhibits a “Matthew effect”: Early successes increase future success chances. We analyze data from a large academic funding program that present a unique opportunity to quantify the Matthew effect and identify generative mechanisms. Our results show that winners just above the funding threshold accumulate more than twice as much funding during the subsequent eight years as nonwinners with near-identical review scores that fall just below the threshold. This effect is partly caused by nonwinners ceasing to compete for other funding opportunities, revealing a “participation” mechanism driving the Matthew effect.

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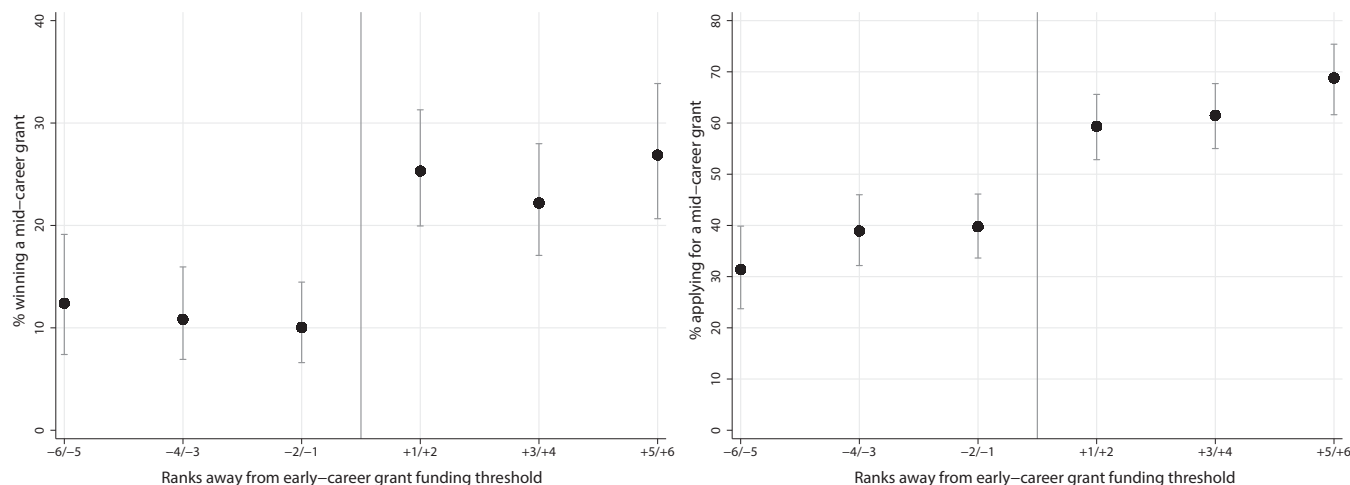
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¹To whom correspondence should be addressed. Email: t.bol@uva.nl.

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award competition not only produces an enduring rift in funding success, but also has a lasting impact on winners' and non-winners' positions in the academic hierarchy.

Discussion

We conclude that funding of early career scientists exhibits a Matthew effect that operates through two mutually reinforcing processes: On the demand side, candidates who won prior awards are evaluated more positively than nonwinners, while on the supply side, scientists who were successful in past contests select themselves into applicant pools of subsequent contests at higher rates than unsuccessful scientists.

The key institutional features of the Dutch academic funding system that enable the observed demand-side dynamics are widespread in grant competitions elsewhere, which suggest that the positive feedback effect uncovered here is likely to extend to other contexts. Prior academic success is often a merit review criterion, investigators are often unlimited in the number of grants they can pursue, and information about an applicant's past grants is often available for consideration by reviewers, panelists, and program directors. Our results thus raise the question of whether funding organizations worldwide should change the common practice of providing information on prior

awards and other investigator success metrics to evaluators of applications.

The observed tendency for winners of earlier grants to try their luck in later competitions in greater numbers than nonwinners suggests that funding agencies could consider outreach efforts aimed at reducing this gap. One costless measure that agencies may take is providing unsuccessful applicants with detailed information on how close evaluation scores were to the funding threshold, which may prevent near-winners with good past proposals from concluding that future odds are too low for investing time and effort in a new application.

Recent studies have documented rising inequality among scientists across the academic world (38, 39). Not only do our findings suggest that positive feedback in funding may be a key mechanism through which money is increasingly concentrated in the hands of a few extremely successful scholars, but also that the origins of emergent distinction in scientists' careers may be of an arbitrary nature. This raises the question of whether, especially in fields where materials and infrastructure costs are modest, the distribution of smaller grants across a larger number of scientists could reduce inequality and improve meritocracy without sacrificing efficiency.

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