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Status Spillovers

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When an actor experiences a sudden gain in status—for example, when a scientist wins a Nobel Prize, or a film director wins an Oscar—what does this jump in status do to the fates of the winner's many 'neighbors'? Do non-winners bask in the reflected glory of the winner, and therefore rise with her? Or conversely, does competition for attention ensue, attenuating the recognition neighbors otherwise would have received? We investigate this question in the scientific community. Using article keywords assigned by third-party experts, we identify articles highly related to publications by eventual appointees to the prestigious Howard Hughes Medical Institute (HHMI). We find that, on average, these "neighbor articles" experience a substantial decline in citation rates after HHMI appointments are announced, relative to controls. That is, neighbors receive substantially less attention when a focal actor receives a prestigious prize. While this negative spillover effect dominates our findings, it is not absolute. For instance, neighbors are shielded from the negative effect if they share a direct social connection with a prize winner. Also, in areas of science in which endorsements are particularly valuable, such as novel fields of research, the spillover effect of a neighbor's prize is instead positive.

INTRODUCTION

Recognition is quintessentially social. It is both an interpersonal relationship that is valued as an end in itself, and it invokes intriguing social dynamics. For instance, recognition typically requires interpersonal judgments; it implies the categorization of actors or objects of subjective value into comparison sets; it depends on the establishment of criteria to hierarchically indexed contenders; it necessitates a determination of whose opinion matters; it initiates deference; and it incites competition among those who aspire to be recognized and those who wish to arbitrate popular opinion. Inevitably, it also generates envy. In short, recognition is a complex social process.

The particular form of recognition we study is the bestowing of a status-enhancing accolade. A prize, which provides a strategic context for studying recognition, is a public judgment about the quality of the work of an actor (Heinich 2009). A central theme in the status literature has been Merton (1968) on the virtuous cycles of the Matthew Effect, in which those who obtain status experience a set of accumulating advantages. In the Matthew Effect, an actor's identity becomes a lens through which his or her output is evaluated. Status produces a self-augmenting dynamic because high status actors benefit from *perceptions* of merit in a manner that amplifies sometimes small, *actual* differences in the quality of their achievements, relative to less-well-regarded but almost equally skilled peers (Lynn, Podolny, and Tao 2009).

The specific question we pose, however, is one that has received remarkably little attention in the status literature. The question is this: *What are the effects of status-conferring prizes on the recognition bestowed on non-winners*? We tackle this question because the status literature has generally been winner-centric and often overlooks the ecological effect of one actor's recognition on the fates of the *many* peers who are engaged in similar undertakings.

In asking this question, we conceive of non-winners in broad terms. We do not simply mean the few, distinguished actors who meet the criteria of an elite consideration set and who are runners-up for an award; the so-called "41st Chairs" in Merton's (1968) reference to the influential thinkers who just missed election to the 40-member French Academy. Rather, we mean the large group of individuals who (often incidentally) work in the same or proximate economic, scientific, or artistic domains in which prize winners make their mark. We term this group, "neighbors". If we zoom out from the level of the individual prize recipient and her most-accomplished peers, the focus on neighbors raises a broader question: what are the implications of an elevation in some actors' statuses for the wider allocation of recognition in a social system?

Existing status research supplies competing predictions for the nature of spillover effects from prizes. On one hand, prizes may distinguish individual actors and consecrate their domains of artistic or scientific endeavor. In so doing, prizes may benefit winners and neighbors alike as greater recognition flows to a community from beyond its existing group of devotees. This infusion of attention and its accompanying resources may help communities become robust, benefitting many in addition to the prize winner. On the other hand, if audiences operate near attention budget constraints or if status hierarchies are strict rank orderings, then status dynamics may unfold as a zero-sum process in which elevations in one actor's prestige may crowd out attention to others in the winner's community. Which dominates—positive or negative spillover effects?

We believe this is an important question for several reasons. The most important of these is that, for all status-conferring awards, the ratio of non-recipients-to-winners is always large. This reflects the fact that all status-enhancing affiliations derive their value from scarcity. For every Nobel Prize awarded, for example, there are many non-winners of the award in pertinent fields of inquiry. Therefore, to fully understand how status processes effect the allocation of rewards in social, cultural, and scientific markets, it is essential to widen the lens and zoom out from a focus on award nominees and winners.

THEORY: A TWO-HORSE RACE

There are at least two accounts for how the bestowal of a prize may affect members of a recipient's community. We label one account an "Endorsement Effect". If endorsement is the dominant social mechanism, there will be positive status spillovers: the benefits of recognition will flow from a winner to neighboring members of her community. Conversely, a second possibility, which we label a "Competitive Effect", may occur if the bestowing of an award induces negative spillovers to neighbors. This would occur if the concentration of recognition on one actor causes attention to be redirected from her neighbors. In the following sections, we present the theoretical rationales for both potential mechanisms and their associated outcomes. We then empirically examine the question in a rich dataset on scientific prizes that is uniquely suited to address these issues.

The Endorsement Effect: Basking in the Reflection of a Neighbor's Glory?

Arguments for positive status spillover effects rest on the idea that there is uncertainty in many judgments of merit—it is difficult to assess a book by its cover, the character of a person by physical appearance, or the quality of a product by its specifications. This uncertainty leads to social influence in evaluations of implicit worth (e.g., Asch 1956; Coleman, Katz, and Menzel 1957; Lynn et al. 2009; Salganik, Dodds, and Watts 2006). When the quality of an actor or object is not easily determined, evaluators typically assess it based on readily observable signals, including affiliations, awards, gossip, product reviews, and other, potential indicators of merit.

Though recent work has highlighted the empirical challenges of clean tests of the magnitude of status effects (Azoulay, Stuart, and Wang 2014; Kovács and Sharkey 2014; Malter 2014; Simcoe and Waguespack 2011), there is an extensive literature on the benefits of high status. Podolny's (2005) metaphor of status "leakage" is a nice characterization of the Bayesian process by which actors infer the merits of someone or something from the affiliations of that person or object. The social potency of awards even can be conceived in terms of a process of status leakage: one can think of the status boost that accrues to prize winners as the lending of prestige from previous to current winners of the accolade. In her recounting of how the Nobel Prize gained such distinction, for example, Zuckerman (1977) argued that the Prize's stature was socially constructed from its earliest recipients. When Planck, Einstein, Bohr and a few among the greatest thinkers of turn-of-the-20th-century Science agreed to accept the Nobel, they created a reverse transfer of their statuses to the Prize. Eventually, the Nobel became so highly regarded that its bestowal enhanced the status of subsequent Laureates.

Of course, the spillover of status from one actor to another extends well beyond award winners: in general, status leakage creates the social value of affiliations. For instance, graduate students derive status from their affiliations with prestigious departments and universities (Merton 1968); law firms from the statuses of universities from which they successfully recruit (Phillips and Zuckerman 2001); new ventures from the prominence of their investors and partners (Stuart, Hoang, and Hybels 1999); and companies from the industrial categories in which they compete (Sharkey 2014). In such circumstances, status-based affiliations serve to endorse otherwise less-known, individual actors.

Likewise, there is suggestive evidence of endorsement-related status leakage, in which certification from prestigious individuals or organizations serves to raise the tide for whole categories of actors. For instance, Rao (1994) found that early in the life of the industry, "certification contests" designed to recognize individual car manufacturers contributed to the legitimacy of the overall industry. More generally, when objects or objects are nested within categories (Hsu and Hannan 2005)—as firms are nested within industries, scientific contributions are bundled within fields, and films are identified with genres—prizes can contribute to the categorical legitimacy of an overall endeavor (Zuckerman 1999).

Of direct relevance to our context, Podolny and Stuart (1995) argued that high status actors have a particular influence in directing paths of change. According to these authors, because of pervasive uncertainty at the early stages of novel technical trajectories, high status actors' choices of where to invest resources become "focal points" (Schelling 1960) that galvanize the attention of the broader community of innovators. They note, for instance, the sway of IBM's decision in 1981 to enter the personal computer industry, which galvanized the entry of many software producers. In areas in which *ex ante* technical characteristics are insufficient to adjudicate among competing approaches, the extent of social proof around each of the competing technical alternatives becomes a primary basis for inventors' resource allocation decisions. It is reasonable to expect this dynamic in science, art and other cultural domains that share this core feature—that is, areas of endeavor wherein the quality of a product is very difficult to judge.

Extending this logic to the context of prominent awards, one can think of a major prize as consecrating more than just the person's work: it endorses an entire field of artistic or scientific pursuit. In this respect, awards may contribute to the categorical legitimacy of an area of work, fueling its adoption (Rossman 2014). The endorsement effect therefore implies: *ceteris paribus, near neighbors receive* ***more*** *recognition when a member of a community wins a significant prize*.

The Competitive Effect: Wilting from the Deflection of Glory?

Although the decided thrust in status research has been on the actor- and category-level benefits of social status, negative effects of status have also been well recognized in the literature. Even the Matthew Effect is regarded as something of a dual-edged sword. Much of the early sociological interest in this phenomenon stemmed from the fact that any accumulative advantage is non-meritocratic in its quintessence: the Matthew Effect implies a disjuncture between actual, virtue-based rewards, and the socially constructed spirals of recognition that may accrue to actors who begin with only a modest quality advantage relative to peers. Small, early leads—perhaps differences so minor that they existed by chance alone—amplify through the social construction of quality to launch very different career outcomes. In this regard, the Matthew Effect stomps merit.

Some have argued that very high status actors inevitably combat a range of distractions that may compromise their performance. Bothner, Kim, and Smith (2012) describe how elite athletes may garner so many opportunities that they become complacent and distracted from the excellence-of-work that first brought them prestige. Likewise, in her study of Nobel Prize winners, Zuckerman (1977) observed heavy demands for speech-giving and the like in the post-Prize period, which crowds out a singular focus on academic work. Examining the personal ramifications of prizes, Jensen and Kim (2015) found that while winning an Academy Award leads to more professional opportunities, it is also associated with higher divorce rates. Another body of work considers the negative emotion of envy or status deprivation, which often is experienced by near-winners when a structural equivalent receives a meaningful recognition (Burt 1987; Heinich 2009).

In a very different tributary of literature, Kovács and Sharkey (2014) argue that audiences for cultural products may judge them more negatively after a product or producer gains recognition. This counter-intuitive outcome may occur for two reasons. First, upon receiving an accolade, audiences may anticipate prize-winning work with higher expectations of quality. If, in their estimation, reality then fails to match the hype, consumers experience disappointment that would not have occurred in the absence of the recognition. Second, prize-winning work may draw broader audiences than otherwise similar, neighboring products. When this occurs, audience tastes become less well matched to the attributes of the recognized piece of work.

Different streams of the literature therefore describe some of the drawbacks of status for prize recipients, but we are unaware of work that directly addresses the broader, system-level dynamics that may ensue with the awarding of prizes or other shifts in status. If indeed there are negative spillovers of status shocks, the question is aptly posed as follows: Which group of market participants *loses* when a focal actor wins a prize, and why do they lose?

Research that has considered negative consequences of prizes for non-winners tends to focus on those coming just shy of victory and often it supplies psychological accounts for these near-winners' subsequent challenges (cf. Jensen and Kim 2015). In contrast, our approach both broadens the scope of non-winners to all members of a community of related endeavor, and it centers on audience-side accounts for negative spillovers, rather than the personal travails of passed-over contenders.

Bothner, Godart, and Lee (2010) provide a valuable starting point for considering the possible negative, distributed effects of status shifts. They define status as, "a zero-sum relational asset that is possessed by social actors insofar as they are highly regarded by other highly regarded actors." If status is a *zero sum* resource, the elevation of any one actor or set of actors must coincide with decrements to others in the social system. Of course, this is descriptive in any true rank-ordering; in such cases, it is axiomatic that an increase in one actor's rank must occur at the expense of one or more alters that formerly were ranked higher. Note too that the ecological consequence of this for a non-recipient of a prize is perhaps more than simply being passed over: if a prize winner experiences a sharp elevation in status in a zero-sum system, a number of alters must endure compensatory losses of status, to allow room for the winner's social climb.

Thinking about status ordering as strict hierarchies is stylized in most settings. However, we believe that there is an important and more general conceptual equivalency that can be drawn between strict rank orders and attention-based systems: in many professional and social arenas, actors operate near budget constraints on attention. In its effect, the presence of such a binding cap implies a tradeoff that parallels the status dynamics of ranks. If one actor experiences a jump in status and therefore garners more recognition from audience members, other actors in the social system must attract less attention. For instance, given the large number of scientific articles that are written each month, a scholar's decision to read one article comes at the expense of reading (large) N alternatives. In fact, this attention allocation problem precisely is what makes prizes in scientific and cultural domains so important: given finite bandwidth, awards are signals that guide the allocation of audience members' scarce attention. This is the curatorial role of the Pulitzer Prize in fiction; the Oscars in film; the Max Weber Award in sociology; and so on.

We believe that an understanding of the contextual effects of status shocks such as major prizes rests in the processes by which audiences allocate attention to non-winners. The simplest possibility is that recognition is monopolized by prize winners when their scientific status crystallizes. Prizes accentuate differences among actors in a domain, and a straightforward diversion of attention occurs, from a relatively more equal distribution across the actors in a market, to a monopolization of recognition by a few notables. In the counterfactual absence of prizes, recognition may have been equally divided. In the post-prize period, winners enjoy disproportionate recognition.

A second, more nuanced possibility is that the declaration of a winner by a prize committee dampens interest in an area, because a formerly contested terrain transitions into a resolved one. This latter possibility is one that is particularly intriguing in scientific areas. It is possible that prizes define canonical works, and the existence of such signature pieces actually detracts from the aggregate attention invested in the broader area of that work. Consider, for instance, the scholarly domain. When a particular piece of work rises to great prominence, a probable implication is that it becomes a de facto reference for an idea. Other scholars will attend less to the field that surrounds the idea, because the stature of the canonical work enables their search to begin and to conclude with it. When deciding whose shoulders to stand upon, prizes often render an obvious choice. Scholars unfamiliar with an idea may assume that the field is more narrowly defined than greater scrutiny would reveal, leading outsiders to disregard entire bodies of research.

In sum, constraints on attention imply a competitive effect that may swamp any endorsement effect. In that case, we will find: *ceteris paribus, near neighbors receive* ***less*** *attention when a member of a community wins a significant prize.*

DATA AND METHODS

We pursue the question of whether a major award generates endorsement (positive) or competitive (negative) spillovers in Science by studying how prizes affect the recognition given to neighbors in the intellectual domains that surround winners. We analyze a salient jump in the status of mid-career academic life scientists in the United States—appointment to be investigators of the Howard Hughes Medical Institute (HHMI). HHMI, a non-profit medical research organization, is a major participant in biomedical research in the U.S. Indeed, the Institute's annual budget is larger than the amount the NSF typically commits to the biological sciences. During periodic, open competitions, the Institute solicits applications from scientists at universities and other research institutions across the country. The selection committee for HHMI almost exclusively comprises members of the National Academy of Sciences, so the profession's most elite scientists choose winners. Once selected, awardees continue to be based at their home institutions, but they are entitled to append the prestigious "& HHMI" to their affiliation in the papers they publish, so that other scientists are reminded of their status.

Appointment to HHMI is a major honor. Indeed, it is the most prestigious accolade that a U.S. life scientist can receive relatively early in his/her career. Consistent with its stature, HHMI appointment is a harbinger of greater accomplishment: the current group of HHMI investigators includes a remarkable 16 Nobel laureates and 152 members of the National Academy of Sciences.

Our analysis is conducted at the scientific article level. When new HHMI investigators are announced, the stature of the recipient immediately jumps. Our research design utilizes prize winner's publications as the conduits of this prize-based status shock to intellectual neighbors. To reiterate, we do not focus on the fate of winning scientists' work itself—that question has been explored at length in past research (cf. Azoulay et al. 2014). Rather, we study the effect of a winner's prize on the attention paid to articles in the vicinity of hers. We call this large collection of scientific peers, "neighbor articles".

Figure 1 provides a detailed graphic of our empirical strategy. In the Figure the three circles represent three groups of articles, which we denote HHMI Article, Neighbor Article, and Control Article. A scientist who is appointed to HHMI in year t published HHMI Article some years *before* winning the Award. Neighbor Article is an existing paper that is scientifically close to the HHMI Article and which also was published prior to the time of the Award. As indicated in the figure, Neighbor Articles are treated starting in year t, which is the time that the article's peer is recognized with the HHMI. Each Neighbor Article is then matched to a Control Article. By construction, Control Articles are not scientifically related to the HHMI award winner's work. Control Articles are included to identify the citation trend that Neighbor Articles would have followed in the (counterfactual) absence of the status reshuffling that results when HHMI winners are announced. This is the comparison in our experiment: HHMI neighbor articles versus scientifically orthogonal control papers.

[Insert Figure 1 about Here]

A critical feature of the research design is that we study only Neighbor Articles and Control Articles that are published before the HHMI award is granted, though we analyze the full time path of citations to these articles, including the post-prize period through 2007. Focusing only on pre-prize articles offers several methodological advantages. First, citations to these articles will occur before *and* after the award, which allows us to construct within-article, difference-in-difference comparisons. Second, because pre-prize articles were authored before a given HHMI was awarded, we can assume that their quality and scientific content is strictly exogenous to the bestowing of the prize.

With the aid of Figure 1 , we can now succinctly summarize the empirical strategy: we analyze the change in rates of citation to Neighbor Articles following the announcement of the HHMI appointment that treats them, relative to the change in rates of citations experienced by closely matched Control Articles. Expressed in terms of the paper-time segments denoted in Figure 1 , we examine how citations rates during the "treated" interval compare to the "untreated" window for the treated cases, as compared to the same difference between the "pseudo-treated" and "untreated" windows for the control articles. As noted, this constitutes a differences-in-differences estimation strategy.

As illustrated in Figure 1 , HHMI Articles define the treatment condition, but these HHMI-authored papers are not themselves in the analysis data. At the risk of redundancy, we reiterate that the question animating our work is how the bestowing of a prize impacts the trajectories of existing articles in the scientific field of the award winner; we do not study how HHMI affects the future outcomes for prize winners.

To implement the research design, we require a high-fidelity method to identify scientific neighbors of the papers of prize winners. We accomplish this with a feature of the National Library of Medicine's PubMed database, which stores a near census of journal articles in biomedicine. All articles in PubMed are indexed with Medical Subject Headings (MeSH) keywords. MeSH terms constitute a carefully curated, constantly expanding vocabulary maintained by subject matter experts at the National Library of Medicine. The approximately 25,000 MeSH keywords provide a very fine-grained partition of the intellectual space spanned by the biomedical research literature. Importantly, MeSH keywords are assigned to each article by professional indexers; not by authors.

The PubMed Related Articles algorithm (PMRA) is a probabilistic topic-based model that uses MeSH terms and title and abstract text to infer relatedness between each newly published article and every existing article in the PubMed bibliome. While the actual implementation is complex (see Lin and Wilbur 2007 for details), in coarse terms one can think of the PMRA algorithm as a measure of structural equivalence between articles in a combined keyword and abstract-word space. The more two articles share MeSH keywords and abstract terms, the nearer they are per PMRA. The output of PMRA includes a continuous measure of intellectual proximity between a focal paper and each of its related papers. We use PMRA to identify the set of Neighbor Articles for each HHMI Article.

Recall that the set of HHMI Articles exclusively consists of those that are published in the pre-prize period. When an author on one of these papers is awarded an HHMI in year *t*, this event triggers treatment for all existing, Neighbor Articles that are scientifically linked to the HHMI Article through PubMed's PMRA algorithm. Because the arrival of citations to Neighbor Articles occurs before and after the time at which HHMI appointment is known, we can assess within-article changes in citation rates, comparing the before- and after-award periods. However, to estimate the causal effect of the HHMI award on citation rates to these scientific neighbor articles, we need to know how treated papers would have performed over time, in the counterfactual absence of the awarding of an HHMI to a scientific peer. That is, we need a control group of papers that are unaffected by HHMI awards but follow a citation trend that parallels what we would have expected of the treated papers, had none of their scientific peers been awarded an HHMI. As we describe in detail below, we construct a control group by selecting papers that appeared in the same journal and same issue of publication as the treated Neighbor Articles (Furman and Stern 2011). Figure 2 illustrates our article retrieval process.

[Insert Figure 2 about Here]

Table 1 reports personal and career attributes of the 399 HHMI winners who "treat" their scientific fields when they receive their award. The table illustrates the distinction of this set of scholars; the modal HHMI is male; he is about 12 years into his independent research career at the time he is selected to become an HHMI; he has written about five research papers in which he served as the lead author or principal investigator in the two years prior to his award and 46 in all years prior to his award; and his past work has been very highly cited.

[Insert Table 1 about Here]

HHMI Articles. We collected all publications for which eventual HHMI investigators were first or last authors, and we constrained this set of papers to include only "article"-type, original research publications. We dropped reviews, letters, and so forth. Also, we restricted HHMI-authored publications to articles published one or two years *before* appointment. This step ensures that "treating" papers are proximate to the time of appointment (though treated papers typically have existed for longer—see below).

Table 2 reports descriptive statistics for the 1,950 HHMI Articles—the complete set of papers written by all HHMI investigators in the two years preceding their awards. These HHMI publications appear in journals with high-impact factors. Consistent with the stature of their authors, these papers subsequently receive high citation counts; the median paper in the HHMI Articles set achieves a cumulative citation count that places it at the 94^{th} percentile of the cumulative citations received by *all* biomedical papers published in its birth year.

[Insert Table 2 about Here]

Neighbor Articles. Each HHMI Article is related through PMRA to an average of 25 Neighbor publications.[1] Of these neighbor articles, we retained only papers published before HHMI appointment and before the corresponding HHMI paper was published. As described previously, the first restriction ensures we observe citations to Neighbor Articles both before and after HHMI appointment, permitting within-article comparisons. The second restriction helps us avoid the potential confound of scientists sorting into intellectual spaces with known or pending HHMI attention. We also constrained Neighbor Articles to have been published no more than 10 years before the time the HHMI receives his appointment. Recall that Neighbor Articles are considered treated in all years after the year that the relevant HHMI appointment is announced.

Control Articles. For each Neighbor Article, we returned to its journal and issue of publication and selected a random article from the same issue as a control. These papers were published at the same time and in the same journal volume and issue as the corresponding Neighbor Article. One constraint imposed is that we accept a control paper only if it is scientifically unrelated to the HHMI Article, per PMRA. Therefore, while control papers are at risk of citation for exactly the same period of time, and by a similar audience, as the set of treated papers, the papers are not in the same scientific sphere. Following convention, control papers are assigned the treatment year of the corresponding Neighbor Article as the "pseudo treatment" year.

This design permits a differences-in-differences estimation strategy. For a given Neighbor Article, we assess within-article changes in citation rates caused by the announcement that a scientist within that article's scientific sphere has been appointed to HHMI, and we benchmark this change in citation rate with the observed change in citations to a same-journal-issue control paper in a different, untreated scientific sphere. In other words, we compare the "before-HHMI" citation rate to the "after-HHMI" citation rate to scientific neighbors of HHMIs, relative to controls.

[1]The count of 25 reflects filtering steps similar to those described for HHMI Article*s* to remove non-research publications from the data. In addition, we restrict the neighbor articles to those that were treated only once—that is, they were related to only one HHMI-authored paper during our analysis window. It is common in these data for Neighbor Article*s* to be multiply treated. This occurs when a focal Neighbor Article falls in the PMRA set of multiple HHMI Article*s* authored by more than one prize winner. Typically, these separate episodes of treatment also occur at multiple time periods. For instance, a Neighbor Article might be written in 1993 and then fall within the PMRA set of articles written by (say) 1997 and 1999 HHMI investigators. This Neighbor Article then poses an estimation challenge because there is no clear definition of pre-treatment for the 1999 award. To address this problem, we limit the dataset to Neighbor Article*s* that are treated by a single prize winner. In robustness checks, we include multiply-treated papers (though we limit the pre-treatment period to the time interval between the year of publication and the year of the first treatment event). This results in a significant increase in the size of the dataset but recovers nearly identical results.

Model

The core models estimate the rate of citations to each Neighbor Article, relative to its Control Article, in each year *t*. In constructing citation counts, we remove all instances of self-citations. Our estimating equation can be written:

$$E[y_{it}|X_{ijt}] = exp[\beta_0 + \beta_1 NEIGHBOR_i \times AFTER_{jt} + f(AGE_{it}) + \delta_t + \gamma_i$$

where *i* indexes articles (Neighbor or Control); *j* indexes the scientist that authored the relevant HHMI Article; *NEIGHBOR* indicates that a focal article *i* is a Neighbor Article to HHMI Article *j* (i.e., it is "1" for Neighbor Articles, and "0" for Control Articles); *AFTER* is an indicator set to one for each year after the HHMI appointment has been announced; $f(AGE_{it})$ denotes a series of indicators of article vintage; the δ_t's represents calendar-year effects; and the γ_{ij}'s correspond to article fixed effects. Because the regressions include article fixed effects and the state of being a Neighbor Article (or Control) is time-stationary, we cannot include a *NEIGHBOR* article dummy independent of the interaction effect with *AFTER*. In results below, we denote the coefficient corresponding to the $NEIGHBOR \times AFTER$ interaction effect simply as, "Treated."[2]

The dependent variable is the annual citation count to article *i*. To ensure that changes in citation rates do not reflect follow-on citation activity of authors, we restrict the dependent variable to non-self-citations. This variable has a lower bound of zero. Following convention, we estimate conditional quasi-maximum likelihood Poisson models (Hausman, Hall, and Griliches 1984). Because observations are potentially correlated within Neighbor Article sets, we cluster standard errors around HHMI investigators.

RESULTS

Table 3 reports descriptive statistics for Neighbor Articles and Control Articles. Several variables in the table are perfectly matched by construction. These include the

[2] In estimating this equation, we face the challenge of simultaneously accounting for time-based trends, age and cohort effects. In particular, it is impossible to observe an article with the same age, same observation year, but a different birth cohort (Hall, Mairesse, and Turner, 2007). The standard solution to this problem is to constrain two or more coefficients to be equal, which will then permit identification (Mason et al., 1973). Corresponding estimates then can be sensitive to arbitrarily chosen values (Rodgers, 1982a; 1982b). However, because our goal is to estimate a clean treatment effect that is purged of confounding variation, and not to estimate the year-age-cohort effects *per se*, this does not pose a problem in our case. To identify the estimating equation, we collapse upper values of the article age variable into a single category. Our results are robust to many, alternate binning strategies.

age of articles at the time the treatment-inducing HHMI appointment is announced, the publication year of the article, and the journal impact factor, which are identical because control articles are matched to treated articles based on their appearance in the precise journal issue in which treated articles are published.[3] Treated and control articles also have a similar number of authors.

[Insert Table 3 about Here]

On average, Neighbor Articles have garnered five more citations than their same-issue Control Articles at the time they are treated with the relevant HHMI appointment (21.8 versus 16.6). This is unsurprising because HHMI winners typically hail from quite active areas of science. The validity of our differences-in-differences design does not require control articles to have the same count of citations as treated articles in the period before treatment. Rather, the difference-in-difference estimator assumes only that treated and control articles follow similar citation trends during the pre-treatment interval. We investigate this criterion in analyses below

Table 3 also reports a number of article characteristics that may prove to contour the magnitude of the treatment effect. One such factor is a (continuous) measure of scientific similarity between the neighbor article and the HHMI paper that treated it, which enables us to assess whether the magnitude of treatment subsides in scientific distance. We construct the PubMed Relatedness Score between an HHMI Article and Neighbor Article as the PMRA value for the paper pair, normalized by the score of the paper that is most related to the HHMI Article. Note that because we constrained all control articles to be scientifically unrelated to HHMI articles, the PMRA score is defined for Neighbor Articles only. All Control Articles are effectively infinite (or undefined) distances from HHMI Articles.

In addition to the scientific proximity score, Table 3 also summarizes whether the Neighbor Article (a) shares any author with the corresponding HHMI Article, (b) has any past or future collaborator of the HHMI-winning scientist, and (c) is cited by the focal HHMI Article. These events occur occasionally among the Neighbor Articles and very rarely among the Control Articles, bolstering confidence in our control selection design (i.e., that control papers occupy different scientific fields than HHMIs). Below, we examine how the treatment effect varies with the presence of authorship, collaboration, and citation ties.

The core regression results are presented in Table 4 . In Model 1, we find a strong, robust, negative spillover effect of HHMI appointment. When a scientist wins an

[3] The data set has a case-control structure. We drew one control article per treated article. It is conventional to assign a "treatment" date to the untreated cases (the controls) that mirrors that of the treated case. When we say that the age of treated and control papers are identical at the time of treatment, it because we calculate the age of the control paper at the time its paired observation is treated (i.e., the year when an HHMI is awarded to a scientific cousin of the treated article.)

HHMI award, the Neighbor Articles that appear in close scientific proximity to the award winner's existing articles experience a sharp decline in subsequent citation rates, relative to controls. On average, Neighbor Articles undergo an 8.42 percent (1-*exp*(-.088)) annual *decrease* in the rate of citations following appointment, relative to control articles. This finding and subsequent extensions lead to the core empirical claim in the paper: the average consequence of a prize is to divert attention away from areas of science that neighbor the prize winner's past work. We find that in the post-prize period, attention dwindles to articles that neighbor publications of award winners, and this competitive loss of recognition swamps any positive endorsement benefit of the prize except in a few ranges of the data, which we describe below.

[Insert Table 4 about Here]

Figure 3 plots the dynamics of the effect of the HHMI on Neighbor Articles, relative to controls. This plot was prepared by substituting the main treatment indicator with separate interaction effects between an indicator for Neighbor Article and dummies for time to and from HHMI appointment. A flat graph with confidence intervals absorbing the x-axis would indicate no statistical difference in citation trends between HHMI-related and control papers. If our control group selection strategy is valid, we should observe a flat line in the pre-treatment / pre-prize interval, and a shift in the slope at the time of the prize if its bestowal causes a shift in citation rates. In Figure 3 , we see a nearly flat graph in the years leading up to appointment, followed by a sharp, monotonic decrease in the treatment effect in years thereafter. Specifically, we see that Neighbor Articles and Controls were on almost identical citation trends prior to the Award, and that publications that are related to HHMI award winners' pre-prize papers experience a precipitous decline in citations once the award is announced. Moreover, this decline is exactly coincident to the timing of the Award. The pre-prize pattern and disjuncture at appointment lends support to our choice of same-journal-issue control articles—it is clear that the prize effect is not a continuation of a downward pre-trend. Rather, the announcement of the prize causes a decline in citations to neighbor articles, relative to controls that were performing on a similar trend in the pre-prize period. We also note that the prize's effect is permanent. The average Neighbor Article never recovers from the negative treatment effect.

[Insert Figure 3 about Here]

With this core result in place, we next turn to a set of analyses to gauge its robustness. To begin, Figure 4 illustrates the temporal boundary of the negative treatment effect. Specifically, we interact treatment with indicators of Neighbor Article age at the time its peer article's author is appointed to HHMI. Note that while article age at a peer's appointment is a non-time-varying characteristic of each paper, the interaction effects are identified because treatment varies within units. Intuitively, if the treatment effect of the prize is causal, we would expect its strength to depend on the time lag between the publication date of Neighbor Articles from the time of the prize. The treatment effect should be weaker for older articles that already are well established at the time a peer wins an HHMI. This is exactly what we find—the treatment effect is most negative for the most recent Neighbor Articles, and it falls to zero for articles that are ages seven years or older at the time the prize that treats them is bestowed.

[Insert Figure 4 about Here]

Model 2 of Table 4 investigates when the competitive effect of the prize is likely to be in greatest force. The PMRA provides a continuous measure of scientific proximity, which permits us to investigate whether the strength of the competitive effect of the prize increases with the scientific proximity between each Neighbor Article and the HHMI Article that treated it. Again as intuition would suggest, Model 2 shows that Neighbor Articles that are more scientifically proximate to the HHMI Articles that treated them are *more* vulnerable to the prize's negative effect. This effect is best demonstrated in Figure 5 , which presents a plot of the treatment effect across deciles of the PMRA relatedness score. This figure shows that the negative effect is most pronounced for the upper 50 percent of the PMRA score—that is, papers that are nearest to the HHMI Article.

[Insert Figure 5 about Here]

The subsequent columns in Table 4 introduce article-attribute moderators of the treatment effect. We begin by investigating whether the competitive effect is offset when there is a direct, collaborative relationship between the authors of neighboring papers and the prize-winner whose award treats their articles. In this case, we would expect the reflection of glory from the prize to be strongest, as direct collaborators of prize winners may even receive "partial credit" for their collaborator's award.

Model 3 shows that the presence of an authorship tie between the HHMI and neighbor author does indeed sharply diminish the negative treatment effect: if the scientific neighbor has an HHMI co-author, the paper suffers no loss of citations at the time the prize is granted. Likewise, Model 4 shows that if an author of the neighbor article is a pre-prize collaborator of the focal HHMI prize-winner, the negative treatment effect is entirely offset. Of interest as a form of a falsification test, Model 5 includes an interaction effect for whether the author of the neighbor article collaborates with HHMI-prize winner *in the future*. In this case, the scientific community is unaware of the collaboration at the time of the award, for the simple reason that the collaborative tie has yet to occur. Consistent with a causal effect, a future collaboration with the HHMI author does not confer current relief from the negative treatment effect.

Recall that, by sample construction, all scientific neighbor articles were published before the time the HHMI was awarded and therefore they pre-date treatment. This enables us to distinguish neighbor articles by whether or not they were directly cited by the focal HHMI Article that resulted in treatment. Technically speaking, all Neighbor Articles were in the risk set of possibly citable papers when the treating HHMI Article was published. Conditional on accounting for scientific proximity, we reasoned that direct recognition from the HHMI winner may shield neighbor articles from some of the negative effect of the prize. Like collaborative ties between the HHMI and the author of scientific neighbors, articles directly cited by prize winner also have been implicitly acknowledged by the winner. Third parties may infer that since a cited Neighbor Article informed or served as an input into a prize-winner's work, it too is of high quality. Model 6 in Table 4 shows that the implicit endorsement of an HHMI-to-neighbor article backward citation does significantly attenuate the negative treatment effect.

Sociological arguments about endorsements focus on uncertainty as a crucial moderator of the potential benefits of high status affiliations (Stuart et al. 1999). Absent uncertainty, judgments of quality may proceed unaffected by social cues. With an eye to generating proxies for the level of ambiguity in judgments of quality of scientific articles, we investigated whether the treatment effect varies with the degree of development of the intellectual space of each HHMI Article prior to the announcement of the prize. We measured the development of HHMI-Article-centric fields in two ways: (1) the average number of citations accrued to Neighbor Articles of a given HHMI Article by the year of appointment, and (2) the average amount of funding from the National Institute of Medicine associated with these articles.

Models 7 and 8 of Table 4 show that the negative treatment effect is increasingly pronounced in the movement toward fields in the upper distribution of mean citations and NIH funding. That is, the endorsement effect of the prize is more salient in new fields, and the competitive effect is at its strongest in highly articulated scientific terrains. Figure 6 illustrates these effects across the full range of the data. We find that for HHMI Article fields in the lowest 10 percent of baseline citations and funding, the treatment effect is actually positive. This suggests that for just-emerging scientific spaces, a prize to any member of the field boosts citations to all articles in the field and endorsement prevails. As fields mature, the implicit endorsement of a prize to one of the field's principal protagonists is no longer so significant to the legitimation of the overall field.

[Insert Figure 6 about Here]

Summarizing the results thus far, Table 4 establishes a large, competitive effect of an HHMI on citation rates to other, incumbent articles in the scientific neighborhoods of prize recipients. This negative effect appears to be causal—as we would expect, it is precisely timed to the awarding of the prize, it declines for articles that are at a greater scientific distance from prize winners, and it disappears for articles that are old when the prize is granted.

The models in Table 5 shed light on the mechanism(s) that might engender this robust set of findings. In interpreting Table 5 , recall that the HHMI-award-winning articles themselves are excluded from all of the analyses; the negative treatment effect is a spillover from the award to the citation rate of neighboring articles, relative to same-issue controls. It is also important to keep in mind that scientific fields in our data are defined narrowly. The PMRA for the typical articles in our data consists of an average of 130 papers. This constitutes a narrow definition of "field", relative to the conventional use of the term. It would be fair to think about the following results in terms of small scientific neighborhoods.

One possible mechanism is that the awarding of a prize deters prospective newcomers from choosing to enter prize-winning fields. If the scientific community perceives an award as associating ownership of a particular corner of the scientific landscape to the lab of the winner and to the scholars in a field who had the foresight to enter before the award, there will be a decline in subsequent-to-the-prize entry of new scientists to work in the areas of prize winners. Likewise, if new entrants expect a higher hurdle to stake scientific identity claims within prize-winning fields, they may eschew such areas for (we presume) nearby neighborhoods.

In Table 5 Models 1a and 1b, we decompose the dependent variable into two, complementary counts. The first is citations from papers whose authors have never cited the focal Neighbor Article previously (we call these, "new citers"). The second is citations with at least one author that has cited the focal Neighbor Article in the past ("repeat citers"). To impose consistency on the data samples used for estimation, both models are estimated on an identical, restricted sample that includes only Neighbor Articles and Controls that receive at least one new-citer and at least one repeat-citer citations.[4] In both models, the estimated treatment effect is negative and statistically significant, although the effect for new citers (-0.117) is about 40 percent greater in magnitude than that for repeat citers (-0.080). A one-sided Wald test comparing coefficients is marginally statistically significant. This provides suggestive evidence that

[4] The regressions include article fixed effects, and therefore variance in the dependent variable is necessary for an article to not be dropped from the data. These two restrictions are necessary to insure that the paired columns in Table 5 are estimated on the same subset of the data. We also ensured that if a treated (control) unit was dropped that the corresponding control (treated) unit was also dropped, thus preserving a one-to-one balance of treated and control units.

the negative spillover effect is driven more by Neighbor Articles' failure to attract new patrons than by a loss of past patrons.

[Insert Table 5 about Here]

We next consider whether the negative treatment effect of a prize on scientific neighbors may, ironically, arise from acts of deference to award winners. The possibility we consider is that authors who enter award-winning fields after the bestowal of a prize may do so at a slightly greater scientific distance from the winner (and therefore, the winner's nearest neighbors). The upshot is that new article writers cede prize-adjacent science to others, which occurs at the expense of citations to the proximate neighbors of prize winners. In other words, the act of deferring scientific territory to the prize winner has a negative effect on citation rates to the winner's scientific neighbors.

We find suggestive evidence that that this is in fact occurring in the data. We use the PMRA algorithm to distinguish citations that come from two different sources: papers within a focal article's PMRA (i.e., very near neighbors) and citations from articles outside of the focal article's PMRA. In Model 2a, the dependent variable is the number of citations to a given Neighbor Article or Control Article from papers that are within its sphere of PMRA-related articles—those that are within the article's immediate intellectual space. In Model 2b, the dependent variable is citations from papers outside this space. As before, the models are estimated using only Neighbor Articles and Control Articles with variation in both dependent variables, so that the subsamples for the two regressions are identical. For both models, the treatment is estimated to be negative. Here, a one-sided Wald test suggests a strongly statistically significant difference in magnitudes. In short, relative to patterns in control fields, the treatment effect is driven primarily by a loss of within-PMRA citations. After an HHMI award is announced, articles that are later produced in a scientific neighbor's PMRA set are less likely to cite the focal Neighbor Article, relative to a control.

This finding tells us that a subtle shift is at play. Rightly or not, awards clarify the attribution of scientific credit (Merton 1968). Therefore, when scholars produce new articles in the vicinity of prize winters, they may keep a slightly greater distance, to stand a better chance for staking a claim to credit. Model 3 of Table 5 provides further, corroborating evidence that this is occurring. In this model, the dependent variable is a measure of keyword overlap between the focal Neighbor Article and the citing articles that arrive in a given year. This was constructed by retrieving the sets of MeSH keywords for each Neighbor Article and citing article pair, dividing the intersection of their keyword sets by the union, and averaging within citation-year cohorts. Ordinary least squares regression with article fixed effects estimates a negative treatment effect: compared to controls, Neighbor Articles experience a decrease in average

MeSH overlap, after the award. Together with the results in Table 4 , this Model suggests that Neighbor Articles receive fewer citations post-prize than would be expected, and that the citations they do subsequently receive are generally from papers that are further away in scientific space.

DISCUSSION AND CONCLUSIONS

We hope to motivate a new focus in research on status. While there is a vibrant literature on status dynamics, our aspiration is to achieve a deeper understanding of how one actor's recognition shifts the fates of the *many* peers who are engaged in similar undertakings. Existing theories imply conflicting expectations of the consequences of status shifts for social neighbors. Under an Endorsement account, status gains to the few result in positive reevaluations of the social standing of the many, as positive social recognition is reflected onto neighbors. Under a Competition account, conversely, status elevations induce even greater stratification in a community because attention that otherwise would have targeted neighbors either is crowded out or diverted to another location. Our empirical setting permitted us to determine which effect, Endorsement or Competition, prevails.

In the context we study—prizes in the biomedical sciences—competition swamped endorsements. We find striking and consistent evidence that scientific output in the intellectual vicinity of work by accolade-winning scientists experiences a sizeable and persistent decline in the rate of attention after prizes are announced. This evidence stands up to a number of falsification and robustness checks. It is important to remember that, unlike prior research on the subject, the yardstick of comparison in our analyses was not prize-winners themselves, but rather comparable science that was not subject to any recent change in status. Had the Neighbor Articles in our data not been indirectly exposed to prize winners via scientific adjacencies, they would have (counterfactually) enjoyed more prolonged attention from the scientific community.

There is a growing interest in the literature about potential negative consequences of status mobility. One recent, interesting project is Jensen and Kim (2015), which investigates the personal-life effects of Academy Award nominations. This work shares our interest in the externalities of prizes, though it focuses on the private lives of nominees and ours concerns the proximate cultural domain in which elevated actors are embedded. An interesting marriage of their work and ours would be a domain-focused project in the context of film that might examine the ramifications of, say, Best Picture awards on the films reflecting a similar genre or subject. More generally, much of the current literature on negative effects of status shocks focuses on status deprivation or other social psychological accounts of winners' or non-winners' subsequent travails. Conversely, our results, along with Kovács and Sharkey (2014), provide support for audience-side mechanisms for negative spillover effects.

While status shocks generally induce an aggregate, negative spillover to the neighbors of a prize winner, we believe that this net negative effect arises because the competitive effect dwarfs endorsements in magnitude, rather than because there is an outright absence of positive status spillovers. Specifically, in different corners of the data, there is clear evidence of endorsements. For instance, we found that in new subfields of science and those with low cumulative grant funding, neighboring articles from the pre-prize period benefitted from the announcement of awards in their scientific proximity. Here, it is useful to return to Podolny's (2001) distinction between two forms of uncertainty: the uncertainty of the "best way" to convert inputs into outputs in a manner that other parties will value (egocentric uncertainty), and the quality of focal actors (altercentric uncertainty). Both these types of uncertainty may be pertinent concerns in undeveloped scientific fields, which is precisely the kind of context in which we expect legitimation from categorical affiliations to matter most. Here, not only is the quality of a given scientist uncertain, but the value of the scientific enterprise in that area is as-yet undetermined. In such conditions, one actor's elevation in status finds their neighbors as having also made the "right bet", and positions them as the foundation for subsequent entry in the space. Subsequent endeavors will be more attentive to establishing the identity of the space, rather than differentiating among actor quality (Kennedy 2005).

This brings us to one of the important boundary conditions of the paper that, paradoxically, is itself about boundaries. There are millions of scientific articles published each year, and a vast quantity of works of art and architecture and cinematography is created. If this titanic body of work is like a large lake, the effect of scarce, status-creating prizes is like dropping a large rock in the lake. The status effects of the prize create a splash in one narrow area, and its effect then ripples across adjacent scientific neighborhoods, but probably diminishes as it travels. We note that to truly understand the ecological effects of the status dynamics of prizes, it may be necessary to observe the entire lake. In short, researchers must confront the classic challenge of a micro-to-macro linkage to truly understand the full ecology of status effects. We believe that the question of how status shocks affect social, scientific, economic, and cultural communities remains open.

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Table 1: Descriptive Statistics for HHMI Investigators in Year of Appointment

	Mean	Std. Dev.	Median	Min.	Max.
Year of Appointment	1992.326	5.158	1993	1984	2003
Year of Highest Degree	1980.752	7.564	1981	1956	1998
Career Age at Appointment	11.574	6.236	10	0	36
Female	0.191	0.393	0	0	1
Nb. of Source Articles	4.887	3.737	4	1	21
Career Publications	46.372	42.780	32	1	285
Career Citations	5828.804	6928.600	3862	111	90245
Nb. Publications in Top 1 Percent of Citations	8.262	8.437	6	0	74

N HHMIs = 399. Note: The table reports descriptive statistics for scientists appointed to the Howard Hughes Medical Institute from 1984 through 2003. Career performance is accumulated up through the year that appointment is announced.

Table 2: Descriptive Statistics for HHMI Source Articles

	Mean	Std. Dev.	Median	Min.	Max.
Publication Year	1990.837	5.035	1990	1982	2002
Number of Authors	4.059	2.165	4	1	15
Publication Age in Year of Appointment	1.477	0.500	1	1	2
Total Forward Citations through 2007	167.674	324.454	87	0	8145
Total Fwd. Cit. (Cohort Percentile)	86.712	18.536	94	0	100
Journal Impact Factor	9.096	7.216	6	0	30
Total Nb. of Neighbor Articles	25.352	31.268	18	1	741

N HHMI Articles = 1,950 Note: This set of 'treating' papers was restricted to articles published one or two years before appointment. Percentiles of total forward citations were calculated within publication-year cohorts. The total number of neighbor articles is the count of related papers (per the PubMed Related Articles algorithm) preserved in the analysis data described in Table 3.

Table 3: Descriptive Statistics for Neighbor Articles and Controls

	HHMI-Related Articles (N = 32,051)			Control Articles (N = 32,051)			Overall	
	Mean	Std. Dev.	Median	Mean	Std. Dev.	Median	Min.	Max.
Publication Year	1988.285	5.939	1988	1988.285	5.939	1988	1974	2001
Number of Authors	3.934	2.169	3	3.870	2.224	3	1	88
Journal Impact Factor	5.459	5.172	4	5.459	5.172	4	0	30
Article Age in Year of Appointment	4.811	2.336	4	4.811	2.336	4	2	10
Stock of Citations at Appointment	21.768	50.652	8	16.648	41.581	6	0	2654
Total Citations Accumulated by 2007	64.063	164.961	26	52.351	121.581	21	1	16193
Total Fwd. Cit. (Cohort Percentile)	74.112	23.424	82	71.085	23.808	77	13	100
Has Any Author of HHMI Source Article	0.070	0.255	0	0.001	0.037	0	0	1
Has Collaborator of Focal Source Author	0.138	0.345	0	0.016	0.125	0	0	1
Cited by Source Article	0.124	0.330	0	0.001	0.026	0	0	1
PubMed Relatedness Score	0.591	0.144	1	.	.	.	0	1

N Articles = 64,102. Note: Articles related to HHMI-authored source articles were identified using the PubMed Related Articles model (PMRA), and retrieved using the open-source FindRelated software (`http://www.stellman-greene.com/FindRelated/`). For each of these Neighbor Articles, we retrieved a random control from the same issue of publication. Articles were filtered in a similar manner as the HHMI articles. Article age and stock of citations are assessed in the year that the focal HHMI appointment was announced. PubMed Relatedness Score is normalized by the score of the most-related Neighbor article and is thus not available for Control articles.

Table 4: Effects of Appointment on Citations to Neighbor Articles and Controls

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treated	-0.088**	-0.045	-0.113**	-0.107**	-0.088**	-0.118**	0.015	0.002
	(0.018)	(0.029)	(0.017)	(0.016)	(0.019)	(0.018)	(0.024)	(0.029)
Treated × Top 50% PMRA Score		-0.080*						
		(0.033)						
Treated × Shares an Author with Focal HHMI Source			0.183*					
			(0.075)					
Treated × Has Pre-Appt. Collaborator of Focal HHMI				0.137†				
				(0.082)				
Treated × Has Post-Appt. Collaborator of Focal HHMI					-0.002			
					(0.035)			
Treated × Cited by Focal HHMI Article						0.095*		
						(0.040)		
Treated × HHMI Article Field in Top 50% of Citations per Article at Baseline							-0.159**	
							(0.037)	
Treated × HHMI Article Field in Top 50% of NIH Funding per Article at Baseline								-0.151**
								(0.041)
Nb. HHMI Investigators	399	399	399	399	399	399	399	399
Nb. of HHMI Source Articles	1,950	1,950	1,950	1,950	1,950	1,950	1,950	1,950
Nb. of Related/Control Articles	64,102	64,102	64,102	64,102	64,102	64,102	64,102	64,102
Nb. of Article-Year Obs.	1,263,764	1,263,764	1,263,764	1,263,764	1,263,764	1,263,764	1,263,764	1,263,764
Log Likelihood	-1,776,835	-1,776,483	-1,775,973	-1,776,351	-1,776,835	-1,776,405	-1,775,562	-1,775,615

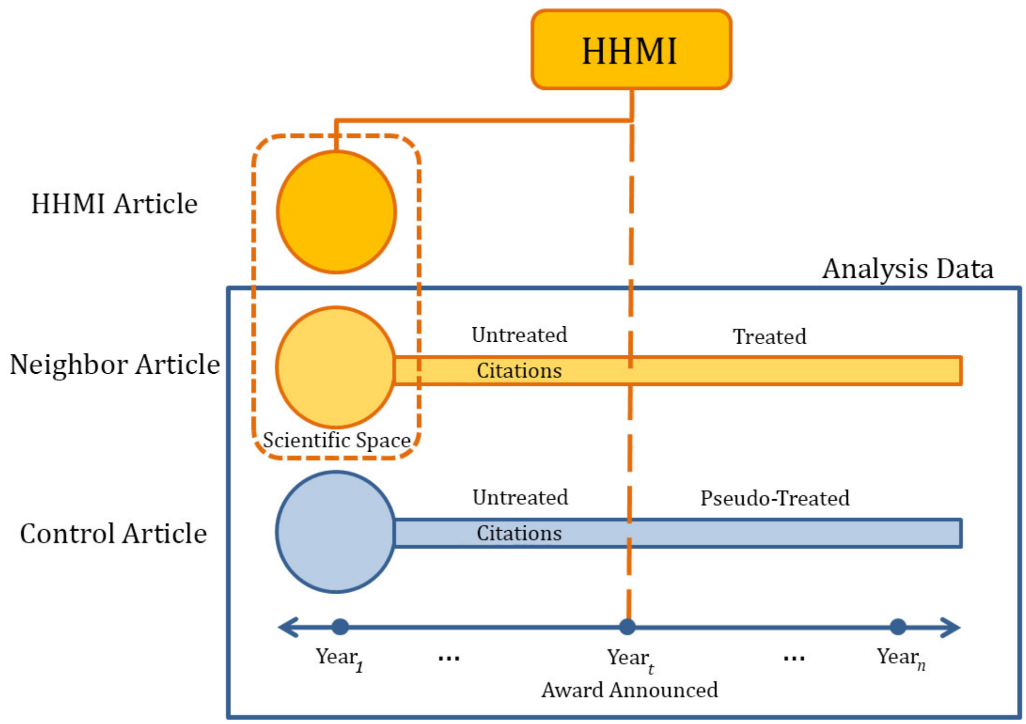
Note: Estimates stem from conditional quasi-maximum likelihood Poisson specifications. The dependent variable is the total number of forward citations (excluding self-citations) received by each Neighbor Article or same-issue Control Article in a particular year. All models incorporate a full suite of calendar year effects, article age fixed effects, and HHMI scientist age (years since terminal degree) fixed effects. Article age was computed relative to the publication year, and scientist age was bins of years since terminal degree. Interactions in Models (2) through (4) pertain to authorship of the HHMI-related paper. In Model (2), treatment is interacted with an indicator that the related paper has at least one of the authors from the HHMI-authored source article. Author overlap in Model (2) is identified using matching last names and first initials. Interactions in Models (3) and (4) include indicators that a collaborator of the focal HHMI—either before or after appointment—is an author on the related paper. These indicators were constructed using scientist unique identifier data. In Model (5), treatment is interacted with indicators that the Neighbor Article was cited by the HHMI-authored source article. In Model (6), treatment is interacted with an indicator that among all papers related to the focal source, the related paper has a PubMed Related Article (PMRA) score in the top 50%. Models (7) through (8) include interactions between treatment and indicators that the source article is in the top 50% of (a) mean forward citations accrued to a source's related papers by appointment, and (b) NIH funding accrued to the field by appointment. Exponentiating coefficients and subtracting from one yields numbers interpretable as elasticities. For example, on average, Neighbor Articles experience a 8.450 percent $(1 - exp(-0.088))$ yearly decrease in the citation rate—relative to Control Articles—after the HHMI appointment. Robust standard errors clustered at the level of HHMI Investigators are reported in parentheses.
† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Table 5: Effects of Appointment on Citations to Neighbor Articles and Controls

	(1a) Nb. Citations (New Citers Only)	(1b) Nb. Citations (Has Repeat Citer)	(2a) Nb. Citations (Within-Field)	(2b) Nb. Citations (Out-of-Field)	(3) Percent MeSH Overlap with Citing Papers
Treated	-0.117**	-0.080**	-0.244**	-0.067**	-0.002**
	(0.014)	(0.026)	(0.020)	(0.020)	(0.001)
Nb. Focal Scientists	399	399	399	399	399
Nb. of Source Articles	1,944	1,944	1,946	1,946	1,950
Nb. of Related/Control Articles	53,287	53,287	53,723	53,723	63,988
Nb. of Article-Year Obs.	1,047,962	1,047,962	1,054,411	1,054,411	741,673
Log Likelihood	-1,308,590	-1,017,325	-611,069	-1,518,410	947,180
H_0: $Appt_a \geq Appt_b$ p-value	0.073†		0.000**		

Note: Estimates stem from conditional quasi-maximum likelihood Poisson specifications. The dependent variable is the total number of forward citations (excluding self-citations) received by each related article or same-issue control in a particular year. All models incorporate a full suite of calendar year effects, article age fixed effects, and HHMI scientist age (years since terminal degree) fixed effects. Article age is computed relative to the publication year. Models (1a) and (1b) decompose forward citations into (a) citations from papers authored by new citers (i.e., none of the authors have cited the focal paper previously) and (b) citations from papers authored by at least one repeat citer (i.e., papers with at least one author that cited the focal paper pre-appointment). Models (2a) and (2b) decompose forward citations into (a) citations from papers related to the focal paper under PMRA and (b) citations from papers outside of the PMRA field. P-values from one-sided Wald tests comparing coefficients across model pairs are reported.
† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Figure 1: Illustration of Empirical Strategy



Note: The figure describes the central empirical strategy. First, for a given HHMI, we retrieve pre-appointment articles. Second, for each HHMI Article, we retrieve the set of Neighbor publications: pre-appointment articles deemed highly related to the HHMI Article through the PubMed Related Papers Algorithm (PMRA). Third, we select a Control Article at random from the same issue of publication as the Neighbor. Fourth, we identify the citations Neighbor and Control Articles receive over time, including before and after appointment. Note that the HHMI Articles are not included in the analysis data. In a differences-in-differences estimation, we assess the relative change in forward citation rates caused by the announcement of HHMI appointments.

Figure 2: Illustration of Article Retrieval Process

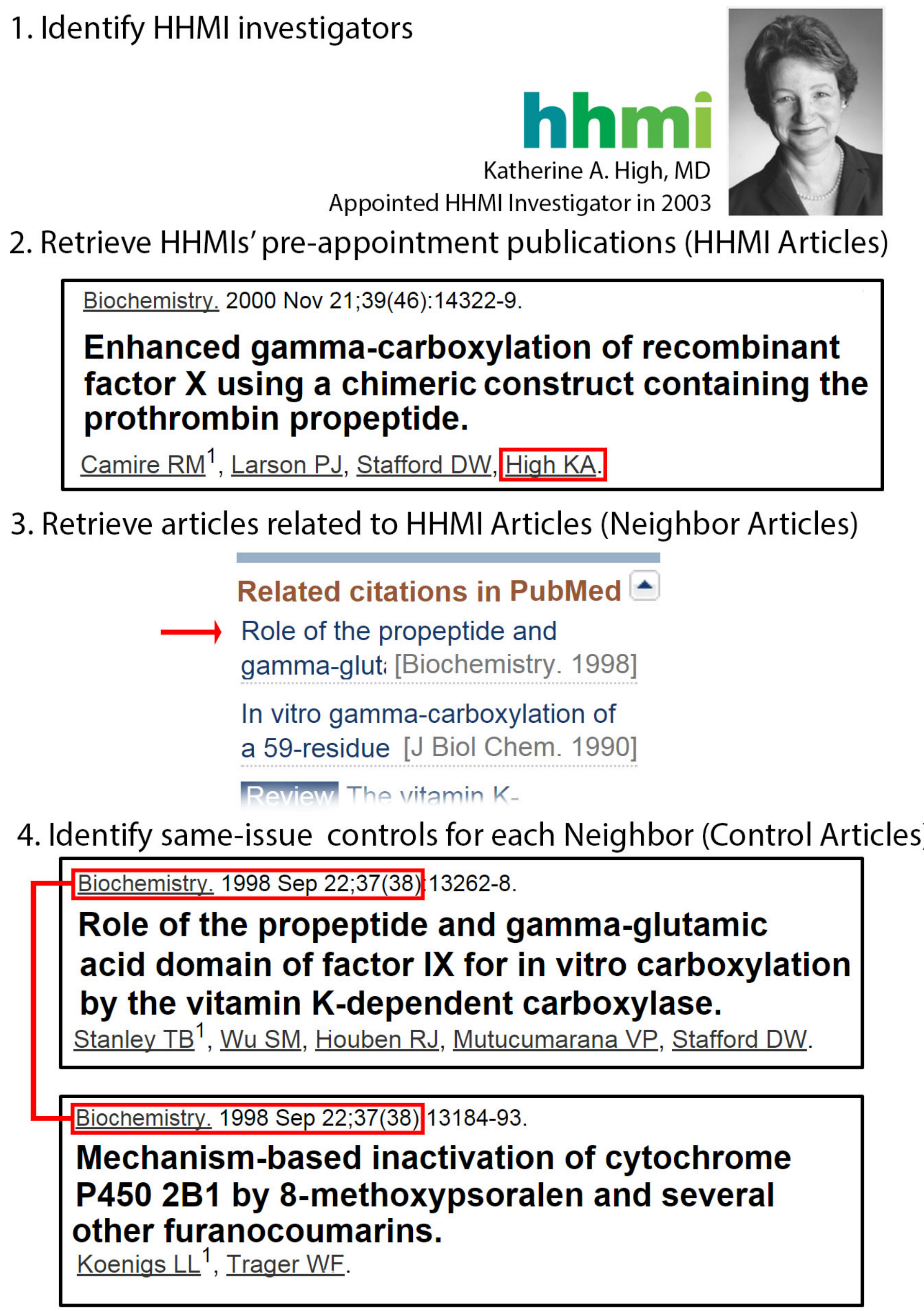
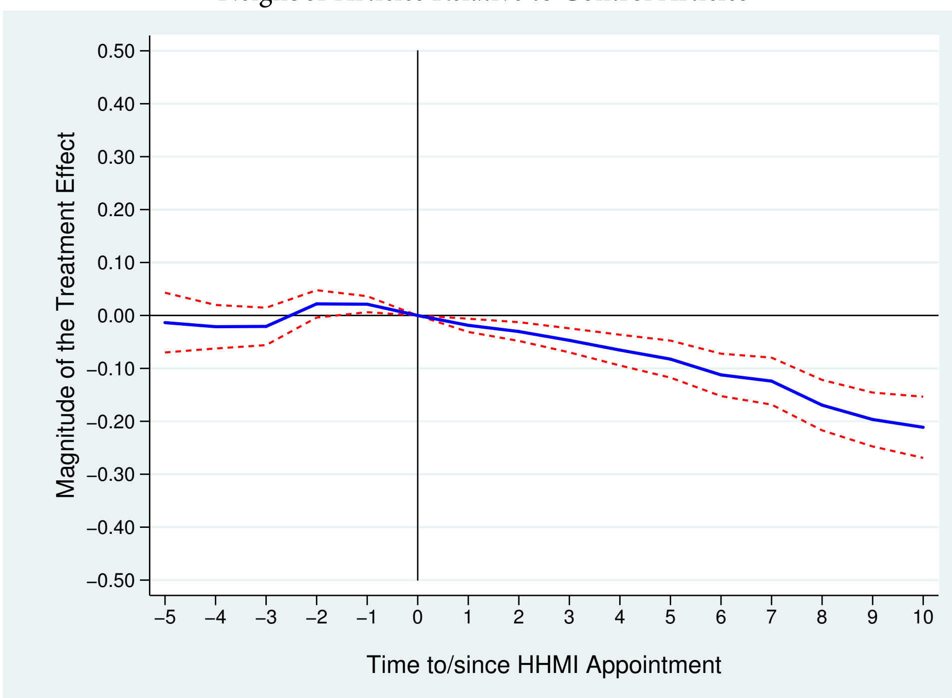
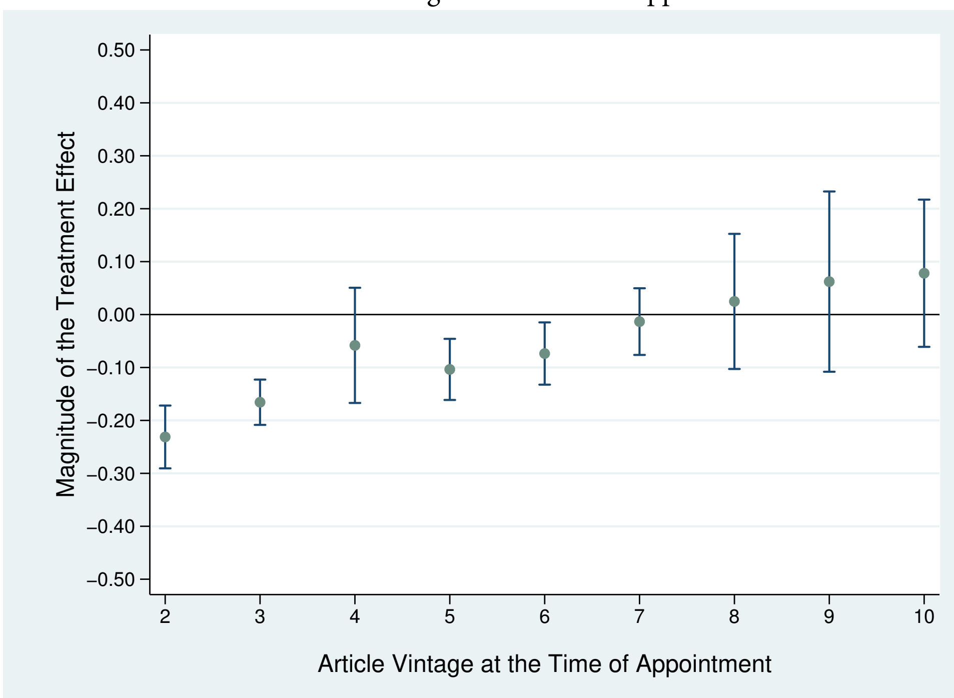


Figure 3: Dynamics of the Prize Effect on Rates of Citation to Neighbor Articles Relative to Control Articles



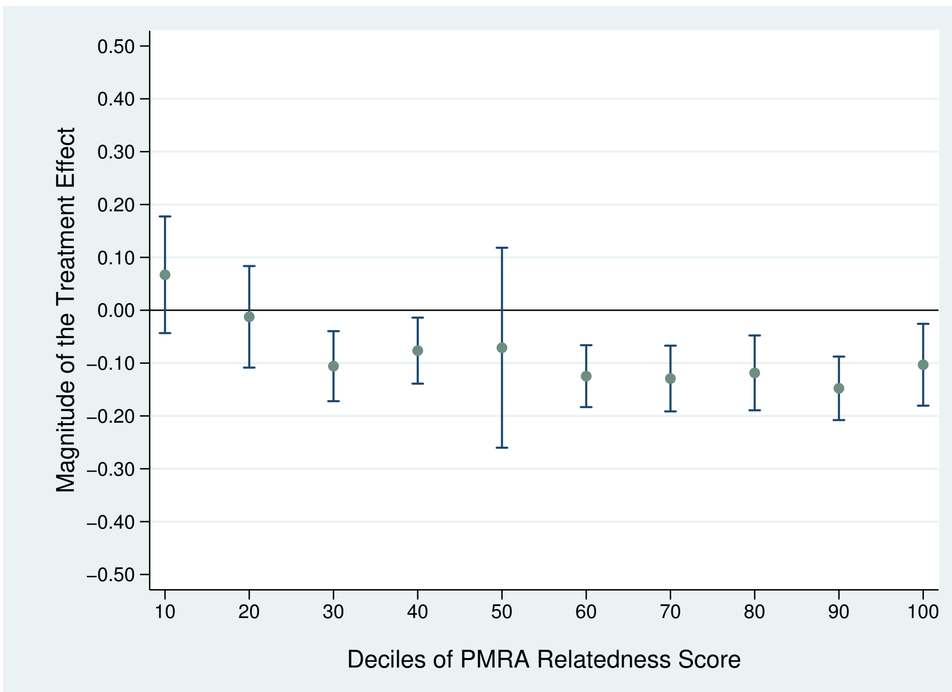
Note: The solid blue lines in the above plot correspond to coefficient estimates from conditional fixed effects quasi-maximum likelihood Poisson specifications in which the citation rates for Neighbor Articles and Control Articles are regressed onto year effects, article age indicator variables, as well as interaction terms between treatment status and the number of years before/elapsed since the HHMI appointment (the indicator variable for treatment status interacted with the year of appointment itself is omitted). The 95% confidence interval (corresponding to robust standard errors, clustered around HHMI investigators) around these estimates is plotted with dashed red lines.

Figure 4: Interaction between the Treatment Effect and
Related Article Vintage at the Time of Appointment



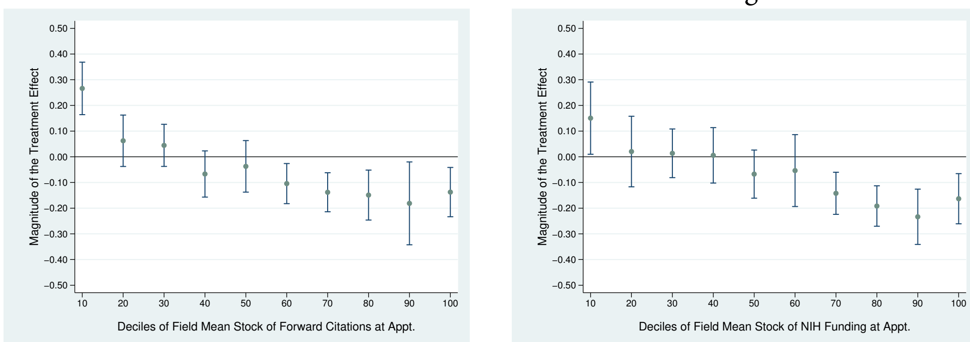
Note: The green circles correspond to coefficient estimates from conditional fixed effects quasi-maximum likelihood Poisson specifications in which the citation rates for Neighbor Articles and Control Articles are regressed onto year effects, article age indicator variables, as well as interaction terms between the treatment effect and the vintage of related articles at the time of the HHMI appointment. Since HHMI Articles are published one or two years before appointment, the interaction terms range from 2 to 10 years prior to appointment. The blue bars denote 95% confidence intervals corresponding to robust standard errors, clustered around HHMI investigators.

Figure 5: Interaction between the Treatment Effect and Deciles of the PMRA Relatedness Score



Note: The green circles in the above plot correspond to coefficient estimates from conditional fixed effects QML Poisson specifications in which the citation rates for Neighbor Articles and Control Articles are regressed onto year effects, article age indicator variables, as well as interaction terms between the treatment effect and indicators of deciles of the relatedness score. The blue bars represent 95% confidence intervals corresponding to robust standard errors, clustered around HHMI investigators.

Figure 6: Interaction between the Appointment Effect and Deciles of Field Mean Stock of Forward Citations and NIH Funding



(a) Field Size: Citations

(b) Field Size: Funding

Note: The green circles in the above plot correspond to coefficient estimates from conditional fixed effects quasi-maximum likelihood Poisson specifications in which the citation rates for Neighbor Articles and Control Articles are regressed onto year effects, article age indicator variables, as well as interaction terms between the treatment effect and indicators of deciles of the field's mean stock of forward citations or NIH funding, accumulated by appointment. The blue bars represent 95% confidence intervals corresponding to robust standard errors, clustered around HHMI investigators.