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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 increase do to the fates of that actor's many 'neighbors'? Do they bask in the reflected glory of the prize recipient, and therefore gain with her? Or, does competition for attention ensue, attenuating the recognition neighbors otherwise would have received? We investigate these questions in science. Using expert-assigned article keywords, we identify papers that are topically related to publications of future appointees to the prestigious Howard Hughes Medical Institute (HHMI). In difference-in-difference specifications we find that, on average, these scientific neighbor articles experience substantial declines in citation rates after HHMI appointments are announced, relative to controls. That is, neighboring articles attract less attention when authors of papers near them receive a prestigious prize. We find this pattern reflects more than the trivial transfer of attention from non-winners to winners: once prizes are announced, actors cede scientific territory to prizewinners and pursue other opportunities. We also find that these negative spillover effects are moderated (or even reversed) by scientists' social connections, and by the novelty and stature of scientific domains.

INTRODUCTION

Scientific opinion is an opinion not held by any single human mind, but one which, split into thousands of fragments, is held by a multitude of individuals, each of whom endorses the others' opinion at second hand, by relying on the consensual chains which link him *[or her] to all the others through a sequence of overlapping neighborhoods.* (Polanyi 1962:14)

Recognition invokes intriguing social dynamics. Selecting who to recognize requires interpersonal judgments; it implies the categorization of actors of subjective value into comparison sets; it depends on the establishment of criteria to hierarchically index 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 others' opinions. Inevitably, it also generates envy. In short, recognition is a complex social process.

We study prizes. A prize is a status-enhancing accolade that is an important form of recognition. Prizes are public judgments about the quality of the work of recipients (Heinich 2009). Because they often create positive shocks to actors' statuses, they present a strategic research site for empirically identifying the effects of status (Azoulay, Stuart, and Wang, 2014). However, the repercussions of prizes extend well beyond their one-time occurrence. Indeed, a central theme in the contemporary literature on social status has been Merton's (1968) theory of the virtuous cycles of the Matthew Effect, in which those who obtain status are the dynamic beneficiaries of accumulating advantages. In the Matthew Effect, an actor's identity becomes a lens through which his or her output is evaluated. The status shock from a prize produces a self-augmenting dynamic through time, because high status actors benefit from *perceptions* of merit in a manner that amplifies sometimes negligible, *actual* differences in the quality of their achievements, relative to less-well-regarded but equally skilled peers (Lynn, Podolny, and Tao 2009).

The extant literature on prizes generally contemplates the effect of a status boost on prize winners. By contrast, we ask: *What are the ecological effects of status-conferring prizes on non-winners*? In asking this question, we refer to non-winners in broad terms. We do not simply mean the few, distinguished actors who meet the criteria to be deemed 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. Instead, we shift the analytic lens to the large group of individuals who work in proximate economic, scientific, or artistic domains in which prizewinners make their mark. We term this group, the "neighbors".

The most important contribution of the paper is the fundamental shift in focus from high status actors to the neighborhoods in which they work. Rather than contemplate the effect of a status-conferring prize on the recipient, we assess the ecological effect of the bestowal on neighborhoods. We conceive of status shocks as treatment effects to specific neighborhoods in a broader ecology of effort. When we zoom out from the level of the individual prize recipient and her almost-as-accomplished peers, the focus on neighbors raises a broader question for which the literature lacks a compelling answer: what are the implications of an elevation in a few, elite actors' statuses for the wider allocation of recognition in a social system? We describe this as the "ecological effect" of status shocks, and we believe it is a very important but neglected dimension of status processes in markets.

Existing research offers competing predictions of the direction of the potential ecological effect of a recipient of a prize on bystanders who work in the vicinity of that actor. On one hand, prizes to individuals may consecrate their domains of artistic or scientific endeavor. In so doing, prizes benefit winners and neighbors alike, though not necessarily in equivalent magnitudes. This occurs if greater recognition flows to the entire neighborhood, relative to pre-prize levels. Conversely, elevations in one actor's prestige may focus the limelight on that actor to such a degree that it crowds out attention to others cast in the winner's shadow. Likewise, a prize may divert attention from the neighborhood altogether, because prizes sometimes resolve the uncertainty of debate. When a matter is settled, people generally attend to it less.

Which dominates—positive or negative spillover effects? We believe this question is important for several reasons. Foremost among them is that for all status-conferring awards, the ratio of non-recipients-to-winners always is large. This must be the case because status-enhancing affiliations derive their prestige from their scarcity. For every Nobel Prize awarded, for example, there are myriad non-recipients of the award in pertinent fields of inquiry. This means that the aggregate effect of status shocks may be most extensively felt by actors who have remained beyond the purview of most existing research. More broadly, we assert that to truly understand how status processes affect outcomes in social, cultural, and scientific markets, it is crucial to widen the lens from a focus on award nominees and winners.

THEORY: A TWO-HORSE RACE

There are at least two, broad accounts of how the bestowal of an award may affect a prize recipient's neighborhood. For rhetorical convenience, we label one account "Endorsement" and the second, "Competition". If endorsement prevails, there will be positive status spillovers: the benefits of recognition will flow from a winner to neighboring members of her community. Conversely, competition implies that 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 others who are proximate. We independently develop the arguments for each of these mechanisms but at the outset, we emphasize that we believe the empirical outcomes we observe are the blended result of counterbalancing forces. The theoretical rationales for each of the mechanisms are sufficiently compelling that in our minds, the question is not whether one or the other is exclusively at work in the data; it is which one outweighs the other, on average, and which contextual conditions amplify one process relative to the other. 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 a positive status spillover effect generally rest on the idea that there is uncertainty in many judgments of merit. This prevalent 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, indirect indicators of merit.

Though recent work has challenged some previous estimates of status effects (Azoulay, Stuart, and Wang 2014; Kovács and Sharkey 2014; Malter 2014; Simcoe and Waguespack 2011), there is a truly extensive theoretical literature on the benefits of high status. Podolny's (2005) metaphor of status "leakage" characterizes the Bayesian process by which actors are thought to infer the merits of others from their affiliations. In Podolny's metaphor, the social value of an award is a process of status leakage: one can think of the status boost that accrues to a prizewinner as the lending of prestige from previous-to-current winners of the accolade. In her recounting of how the Nobel Prize gained distinction, for example, Zuckerman (Zuckerman 1977) argued that the Prize's stature was socially constructed from its earliest recipients. When the greatest thinkers of turn-of-the-20th-century science—Planck, Einstein, and Bohr—agreed to accept the Nobel, they created a reverse transfer of their prestige to the Prize. Eventually, the Nobel became so highly regarded that its bestowal enhanced the status of subsequent Laureates, despite their extremely high levels of pre-prize recognition.

Of course, the spillover of status from one actor to another extends well beyond award winners: in general, the circumscribed flow of status across the ties in a network is what creates the reputational 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 ; new ventures from the prominence of their investors and strategic partners (Stuart, Hoang, and Hybels 1999); and companies from the industrial categories in which they compete (Sharkey 2014). In such circumstances, status-based affiliations endorse otherwise less-known, individual actors.

Likewise, endorsement-related status leakage may occur when certification from prestigious individuals or organizations raises the tide for whole groups of actors. When actors or objects are nested within categories (Hsu and Hannan 2005), such as when firms cluster within industries, scientific contributions bundle to fields, and films group to genres, prizes may contribute to the legitimacy of overall categories (Zuckerman 1999). Prestigious prizes may build a field's collective legitimacy (Lounsbury and Glynn 2001). This is likely to be particularly true for an incipient field, when a status boost to an individual actor can be a seminal catalyst to the coalescence of a collective identity.

Of direct relevance to our context, Podolny and Stuart (Podolny and Stuart 1995) argued that high status actors have a particular influence in orchestrating paths of change. According to these authors, because of pervasive uncertainty at the early stages of novel scientific and 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. As an example, they describe the sway of IBM's decision in 1981 to enter the personal computer industry, which spurred 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 other actors' resource allocation decisions. It is reasonable to expect this dynamic in science, technology, art and other cultural domains that share the core feature that the true, underlying quality of a product can be very difficult to judge *ex ante*.

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 a 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 emphasis in status research has been on the actor- and category-level benefits of social status, negative effects of status also appear 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 cycles of recognition that accrue to actors who begin with only a modest quality advantage relative to peers. Small, early leads—perhaps differences so minor that they exist by chance alone—amplify through the social construction of quality to launch very different outcomes over a life course. In this regard, the Matthew Effect can stomp merit.

Some have argued that very high status actors inevitably confront a range of distractions that may compromise their performance. Bothner, Kim, and Smith (2012) describe how elite athletes garner so many opportunities that they can become complacent and distracted from the excellence-of-work that first brought them prestige. Likewise, in her study of Nobel Prize winners, Zuckerman (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 (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 different tributary of literature, Kovacs and Sharkey (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 because audience members 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.

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, ecological dynamics that may ensue with the awarding of prizes or other shifts in status. If indeed a competitive process results in 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 might 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 (Bothner, Godart, and Lee 2010) provide a valuable starting point for explaining negative, ecological 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 true in any rank-ordering; in such cases, it is an axiom 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 more than simply being passed over: if a prizewinner experiences a sharp elevation in status in a zero-sum system, a number of alters must endure compensatory losses of status, to create a place in the rank system for the winner's social climb.

Thinking about status hierarchies as strict rank orderings is stylized in most settings. For instance, what is the true rank ordering among researchers in any subfield of scientific research? However, we believe that there is an important and general conceptual equivalence that can be drawn between strict rank orders and attention-based status systems. The similarity is created by the fact that in many professional, social, and market arenas, participants operate at or near the limit of their budget constraint on attention. In its effect, the presence of such a binding cap implies a tradeoff that parallels the status dynamics of a strict rank ordering. If one actor experiences a jump in status and therefore garners more recognition from audience members, other actors in the social system necessarily must attract less attention. For instance, given the large number of scientific articles that are written each month, if one article rises to prominence, scholars' decisions to read this article come at the expense of reading (large) N possible alternatives. In fact, the attention allocation problem precisely is what makes prizes in scientific and cultural domains so influential: given finite bandwidth, awards are signals that guide the allocation of audience members' scarce attention across a vast array of competing alternatives. 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 prizewinners when their 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 greater monopolization of recognition by one or a few notables. In the counterfactual absence of prizes, recognition may have been (more) equally distributed. In the post-prize period, winners enjoy disproportionate recognition. In this case, the upshot of the bestowal of a prize is to cause a reallocation of attention that results in its diversion from "competitors" in the neighborhood of the prizewinners. This is a straightforward reallocation of attention within a segment or category of a market: the prizewinner garners more; everyone else experiences a proportionate loss; and the overall distribution of attention exhibits greater skew.

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. If this occurs, its effect will tend to be more dramatic than a simple reallocation of intra-neighborhood attention. Rather than simply creating a shift in the distribution of attention within a domain, this mechanism results in a net reduction in collective interest in the neighborhood. We consider this possibility 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.

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 alone. 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 much of the work that is adjacent to that of a prizewinner's contribution.

Though perhaps counterintuitive at first thought, we believe this is a common scenario. By their very nature, canonical works partially function to truncate debate. If this happens, attention may divert from an entire neighborhood: when prizes function to clarify what is most important in a neighborhood, the overall level of attention to it may attenuate. Note that this does not imply any gain or loss in attention to the prizewinner itself; the argument concerns the ecological impact of the prize on the winner's neighborhood.

In sum, a set of theories leads us to the possibility that a competitive effect may swamp any endorsement effect. Note as well that these are all causal theories of the ecological byproduct of a prize. In each case, in the counterfactual absence of the awarding of the prize, attention dynamics are unchanged from whatever trends were underway just prior to the the time the prize was bestowed. If the competitive effect dominates, 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 surrounding winners. Our analysis is conducted at the scientific article level. We describe our approach in much more detail below, but essentially it is as follows: we identify publications of award-winning scientists; retrieve publications addressing similar content ("Neighbor Articles"); and examine the change in Neighbor Articles' citation rates after awards are announced, relative to carefully selected control articles in other scientific areas.

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 United States. 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 or 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.

We study how HHMI appointments change the allocation of attention to the broader body of research in which awardees' work is situated. Crucial to understanding our empirical approach is recognizing that while we use HHMI prizewinners' publications as the *conduits* of this prize-based status shock to scientific neighbors, prizewinners' publications are *not* in our sample. 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".

To implement the research design, we require a high-fidelity method to identify scientific neighbors of the papers of prizewinners. We accomplish this with a core feature of the PubMed database maintained by the National Library of Medicine (NLM), which stores a near census of journal articles in biomedicine. To help researchers identify work on related topics or concepts, the NLM indexes all articles 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.

As researchers browse articles on the NLM website, a list of links to similar articles appears in a sidebar. These lists are also accessible through a public API. Sets of related articles are identified through the PubMed Related Articles algorithm (PMRA), a probabilistic topic-based model that infers relatedness between each published article and every existing article in the PubMed bibliome. The algorithm yields a continuous relatedness score between any pair of papers derived across proximities in three linguistic spaces: article MESH keywords (human-curated by the Library of Medicine), article title words, and article abstract words. 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-title-abstract word space. The more two articles share MeSH keywords and title and abstract terms, the nearer they are per the PMRA algorithm. The output of PMRA includes a continuous measure of intellectual proximity between a focal paper and each of its related papers. Therefore, one can think of the PMRA set of any article as a compact scientific field that is centered on the topic of each individual article in the bibliome. We utilize PubMed's public API to identify the PMRA-defined set of Neighbor Articles for each HHMI Article.

The graphic in Figure 1 illustrates our empirical strategy. In the figure, the three circles represent three types of articles, which we denote with the labels, HHMI Article, Neighbor Article, and Control Article. Consider a scientist who is appointed to HHMI in year *t* and published an HHMI Article some years before winning the Award. A Neighbor Article is an existing paper that is scientifically close to an HHMI Article as determined by membership in its PMRA set, where the Neighbor Article was published prior to both the HHMI Article and the time of the Award.

[Insert Figure 1 about Here]

As indicated in the figure, Neighbor Articles are treated after year *t*, which is the time that the Neighbor Article's peer is recognized with the HHMI. 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.

To create this data structure, we match each Neighbor Article to a Control Article. By construction, we choose only Control Articles that are scientifically *un*related to the HHMI award winner's work. This is the comparison in our experiment: HHMI neighbor articles versus scientifically orthogonal control papers. Contrast this to a traditional research design, which might consider HHMI-winning articles to be the treated units and Neighbor Articles to be the controls. Our experiment runs at a one-step remove: Neighbor Articles in a prizewinner's PMRA are the treated units, and controls are similar quality articles with identical exposure times, but in different areas of science.

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. (In the Robustness section, we describe alternate control selection strategies.) 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 never in the same scientific fields as treated papers. Following convention, control papers are assigned the treatment year of the corresponding Neighbor Article as the "pseudo treatment" year.

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 awards affect the future outcomes for prizewinners. By benchmarking Neighbor Articles against carefully chosen Controls (and *not* the HHMI Articles), we are able to go beyond the host of comparative studies that contrast award winners against runners-up and assess the absolute effect of status shocks on Neighbors. This is a crucial difference between our work and previous research designs: because of the rich data in this setting, we are able to construct a control group of articles that truly is unaffected by the status shock, and that allows us to pin down the counterfactual citation rates that the scientific neighbors of HHMI-authored papers are likely to have experienced if they were never exposed to the status shock of being adjacent to a prizewinner.

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. Focusing only on articles published pre-prize offers several methodological advantages. First, citations to these articles occur before *and* after treatment, 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. These articles were written well before a focal HHMI was selected, which all but ensures that the existence and content of all Neighbor Articles is exogenous to the bestowal of the award.

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 just noted, this constitutes a differences-in-differences estimation strategy.

Table 1 reports career attributes of the 393 HHMI winners who "treat" their scientific fields when they receive their HHMI award. The table illustrates the scientific eminence 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 articles 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 1,950 HHMI Articles that met these criteria, which is 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 27 Neighbor publications preserved in the analysis data.[1] Of these neighbor articles, we retained only papers published before HHMI appointment and at least two

[1] The count of 27 neighbor articles reflects filtering steps similar to those described for HHMI Articles. First, we remove all non-research articles from the neighbor article data. In addition, we restrict Neighbor Articles to have been published at least two years before the corresponding HHMI Article. 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 Articles to be multiply treated. This occurs when a focal Neighbor Article falls in the PMRA set of multiple HHMI Articles authored by more than one prizewinner. Typically, these separate episodes of treatment also occur at different 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

years 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 insures that we avoid the potential confound of scientists sorting into intellectual spaces with known or pending HHMI attention, and it makes the results more conservative. 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. As described above, we construct a control group by selecting papers that appeared in the same issue of the same journal of publication as the treated Neighbor Articles. In robustness checks, we are able to further match on article and PMRA field characteristics to eliminate nearly all sources of heterogeneity (Furman and Stern 2011). Figure 2 describes the article retrieval process.

[Insert Figure 2 about Here]

Model

The principal 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. The 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 co-

for the 1999 award. To address this problem, we limit the dataset to Neighbor Article*s* that are treated by a single prizewinner. In robustness checks, we include multiply-treated papers. Doing so results in a significant increase in the size of the dataset but recovers similar, but even stronger, results.

efficient 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. The dependent 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. Exact matches include the 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 six more citations than their corresponding, same-journal-issue Control Articles at the time they are treated with the relevant HHMI appointment (26.2 versus 20.2). This is unsurprising because HHMI winners typically hail from quite active areas of science. It is important to underscore that the validity of the differences-in-differences design does *not* require control articles to have the same count of citations as treated articles in the period before

[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). It is known that corresponding age-cohort-year 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.

[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 is 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).

treatment. Rather, the difference-in-difference estimator assumes only that treated and control articles follow similar citation trends during the pre-treatment interval. We verify this assumption in analyses below, and we have run (and will report) supplemental analyses that rely on matching estimators to eliminate all observable pre-treatment differences between treated and control articles.

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. By construction, all Control Articles are effectively infinite (or undefined) distances from HHMI Articles; they are selected from unrelated areas of science to insure that their citation trajectories are unaffected by HHMI awards.

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 almost never among the Control Articles, bolstering confidence in our control selection design (i.e., that control papers inhabit 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. What does this mean in practice? When a scientist wins an HHMI award, the Neighbor Articles that already existed in close scientific proximity to the award winner's previously published articles experience a sharp decline in subsequent citation rates, relative to controls. On average, Neighbor Articles undergo an 6.98 percent (1-*exp*(-.072)) 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 effect of a prize is to divert attention away from areas of science that neighbor the prizewinner'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 indicates no statistical difference in citation trends between HHMI-related and control papers. If the control selection strategy is valid, we should observe a relatively 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 change in the baseline citation rates to Neighbor Articles.*

[Insert Figure 3 about Here]

Figure 3 portrays a nearly flat graph in the years leading up to HHMI 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 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 from the figure 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. As well, recall that because we include article age fixed effects, the observed decline is beyond what would be expected with a "natural" decay in citation over time from the article's starting point, relative to controls. In other words, we can think of the treatment effect as accelerating the rate of decay that would have occurred anyway, as a byproduct of the aging of the article and the advancement of science.

We also note that the prize's effect appears to be permanent. On average, Neighbor Articles never recover from the negative treatment effect, as evidenced by the monotonic decline in the citation rate over time, relative to the trend established by control articles. An alternative pattern still consistent with the negative main effect reported earlier would be a sharp decline followed by an eventual (partial) recovery. To explain the treatment effect's persistence, we return to the accumulative advantage process that Merton (1968) labeled the Matthew Effect: initial differences in status imbue a positive tint to the lenses through which quality is assessed. But before any such evaluative process can occur, it is a necessary condition that audience members must first know of a product's existence. Put differently, in all markets for all things, exposure precedes adoption.

This inherent virality in the accrual of attention in cultural markets contributes to the positive feedback dynamics we have described. Exposure follows from the adoption of others, which means that the more people who read a book, watch a film, or cite a scientific article, the more other, as-yet non-consumers become aware of the focal product's existence. It is the natural order of things—we must be aware of something before we can adopt it. This feedback cycle is likely in science because citations in articles serve as small billboards for existing work: though there are other search and information channels that lead to the discovery of existing work, the scientific community in part learns about research through the act of citation. The more an article is cited, the more it comes to the attention of scholars who read the citing work. Of course, this general process extends beyond just citing behavior.

The pertinent observation is that the feedback processes we have just described also contributes to permanent unraveling in citation trajectories. This is because each loss of a citation means that there are fewer would-be adopters exposed to the article in the next period, and so on. Thus, a diversion of attention during the diffusion process can have persistent consequences.

Because we include a census of the PMRA-related Neighbor Articles for each HHMI Article, our findings at the article level have a ready interpretation at the "neighborhood level": scientific spaces centered around work of (eventual) prize winners generally experience a loss of attention after awards are announced.[4] With this core result in place, we next delineate the bounds in which the competitive effect of treatment is present by examining within-neighborhood and between-neighborhood variation in the treatment effect. We begin by examining the temporal boundary of the negative treatment effect: we interact treatment with indicators of Neighbor Article age at the time its peer article's author is appointed to HHMI. This result is reported in Figure 4 a. 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

[4]There is one, small possibility that might create a disjuncture between the article-level results and the neighborhood level of analysis. Because our methodology excludes citations received by prizewinners' articles themselves, the results miss any countervailing uptick in citations to HHMI articles after the award, which would then offset some of the loss in citations to the other papers in HHMI winner's neighborhood. However, because there are an average of 27 Neighbor Articles for each of HHMI Article in the data, the post-award increase in citations to HHMI articles that would be necessary to offset the loss of citations across all 27 papers per neighborhood would be quite large. Still, in robustness checks, we conducted additional analyses that included HHMI Articles and same-issue controls. These analyses almost exactly replicated the pattern reported above.

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]

Having examined a temporal boundary, we next consider whether the competitive effect of the award depends on scientific proximity. If the negative effect we observe is indeed the result of a social process, then the effect should naturally attenuate as neighbors become more scientifically distant from the "epicenter" of a status shock. Model 2 of Table 4 includes an interaction between treatment status and an indicator that turns on when the normalized PMRA score is in the top 50% of the sample distribution. As intuition would suggest, the competitive effect is generally reserved to the top 50 percent of the PMRA relatedness score. Further detail is presented in Figure 4 b, which presents a plot of the treatment effect estimated for each decile of the PMRA relatedness score. This figure shows that the negative effect is fully attenuated for the lower 20% of the PMRA relatedness score.[5]

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 prizewinner 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 prizewinners may even receive "partial credit" for their collaborator's award.

Model 3 of Table 4 shows that the presence of an authorship tie between the HHMI and neighbor author sharply diminishes (or even reverses) the negative treatment effect: if the author of the scientific neighbor article 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 prizewinner, the negative treatment effect is entirely offset. Of interest as a falsification test, Model 5 includes an interaction effect for whether the author of the neighbor article collaborates with an HHMI-prizewinner *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 what we expect of a causal effect of the award, a future collaboration with the HHMI author does not confer current relief from the negative treatment effect.

By design, all scientific neighbor articles were published before the time the HHMI was awarded and therefore they pre-date treatment. This enables us to distinguish

[5] Additional analysis suggests the recovery visible in the top decile of the PMRA relatedness score is partly due to the presence of authorship ties between the Neighbor Article and HHMI Source Article (see discussion of Model 5 in Table 4). It also is conceivable that this spike reflects a separate, countervailing endorsement effect enjoyed by extremely similar work.

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 prizewinner 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 prizewinner's work, it too is of high merit. 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.

We now consider the effect of broader, ecological conditions on the nature of status spillover effects. Sociological arguments about endorsements focus on uncertainty as a crucial moderator of the potential benefits of high status affiliations (Stuart et al. 1999). Under conditions of certainty, judgments of quality are 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 stature 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 journal impact factor (JIF) of all of an HHMI Article's PMRA-related 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 journal status. Figures 4c and 4d illustrates these effects across the full range of the data. We find that for HHMI Article fields in the lowest 20 to 30 percent of baseline citations or journal impact factor, the treatment effect is actually *positive*. This suggests that for just-emerging scientific spaces in less prominent publication outlets, a prize to any member of the field boosts attention to all articles in the field and an endorsement process overwhelms the competitive effect we observe elsewhere in the data. As a field matures and the value of its scientific endeavor is more assured, 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.

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 prizewinners, and it disappears for articles that are old when the prize is granted. Also, while the results point overwhelmingly to the dominance of competitive effects, we identify article-pair and field-level conditions where endorsement is more pronounced: members of prizewinners' (pre-prize) co-authorship networks, work receiving direct endorsement in the form of citation from the prizewinner's articles, and research in fields previously lacking in stature, either in attention or publication outlet status.

We now consider mechanisms that might engender the robust competitive effect we find. First, consistent with the core of our competitive effect arguments, we investigate whether the negative, competitive effect for Neighbor Articles corresponds to positive gains for HHMI articles. To do this, we examine the number of citations received by HHMI Articles in the year immediately following appointment and incorporate this information as a treatment interaction. As before, we continue to compare Neighbor Articles to same-issue controls.[6] In Model 1 of Table 5 , we include interactions between treatment status and an indicator that the article's relevant HHMI Article is in the top 50% of citations received the year after the appointment announcement. Similar to the results found for the PMRA score interaction (Model 2 of Table 4), we see that the competitive effect is reserved for articles neighboring HHMI Articles in the top 50% of citations in the year after appointment. That is, articles neighboring HHMI Articles experiencing an especially large *gain* in attention post-appointment are themselves especially susceptible to a *decline* in attention. Figure 5

provides a plot of the interaction of treatment and deciles of HHMI Article citation changes.

[Insert Figure 5 about Here]

The foregoing result suggests the competitive effect may arise from direct transference of attention from neighbors to award winners, though we have reason to believe that other processes also are at play. In their study of the Matthew Effect in our context, Azoulay et al. (2014) found evidence of only a modest benefit in citation rates to HHMI appointees because of their award. Though we necessarily employ a different research design than those authors, we suspect that the loss of citations to Neighbor Articles is not simply recaptured by the prizewinner alone. In other words, the results are driven by more than just a transfer of attention from neighbors to prizewinners.

One, ironic possibility is that the negative treatment effect of a prize on scientific neighbors may arise from acts of deference to award winners. 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 their close associates, there will be a decline in

[6] The reason for retaining same-issue controls is to identify whether Neighbor Articles do absolutely better or worse following appointment. Directly comparing Neighbor Articles to HHMI Articles risks confounding: a disparity between these articles could occur due to the HHMI Articles receiving more attention post-appointment irrespective of any change to Neighbor Articles.

subsequent-to-the-prize entry of scientists working in the areas of prizewinners. Additionally, authors who do enter award-winning fields after the bestowal of a prize may do so at a greater scientific distance from the winner (and therefore, the winner's nearest neighbors), in deference to the prizewinner's implicit ownership of scientific turf. The upshot is that those who would otherwise attend to the activities of prizewinners and their neighbors cede prize-adjacent science to others, resulting in a decline in citation rates to near neighbors.

We find suggestive evidence that that this is in fact occurring in the data. To examine deference, we decompose the dependent variable into two, complementary counts. 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. This decomposition allows us to estimate the treatment effect on both sources of attention and compare the estimated magnitudes.

[Insert Table 5 about Here]

In Model 2a of Table 5 , 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. 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. The treatment effect remains negative in both models, but a one-sided Wald test suggests a strongly statistically significant difference in magnitudes: the loss of citations from within-field alters is more than 2.5 times the magnitude of the loss from out-of-field papers. 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 the base rates established in control fields.

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 years. 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 prize. Considering this model and previous results, we see 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.

The results of Table 5 hint at an additional explanation of why Neighbor Article citation rates continue to decline relative to Control Articles (Figure 3). Whereas HHMI award winners may amass more attention and (in time) more scrutiny, Neighbor Articles' pool of followers may shrink: there are simply fewer people prospecting in the neighborhood.

Robustness Checks

The core result of a competitive effect of status on Neighbor Articles derives from a convincing regression, because of the inclusion of article fixed effects and because we find almost no difference between treated and control citation trends in the pre-appointment period (see Figure 3). Still, we conduct many, additional analyses to test the validity of the findings.

First, as an additional check on article-level heterogeneity, we employ coarsened exact matching to improve on randomly selected same-issue controls (Iacus, King, and Porro 2012). We use CEM to select Control and Neighbor Articles that have nearly identical pre-HHMI characteristics. First, we match on citation stocks between treated and control papers at the time of treatment. In this sample, at treatment the citation means are 24.930 and 24.627 for Neighbor Articles and Control Articles, respectively. When we match on pre-treatment citation counts, we estimate a nearly identical, negative, average treatment effect (-0.087). See column 2 of Table 6 .

[Insert Table 6 about Here]

Second, we examine the potential role of field heterogeneity in explaining our results. We do this to ascertain whether the decline in citations observed in the treated articles is coincident with a cresting in the level of activity in a field just before HHMI appointment. Under this alternative explanation of the findings, the negative effect associated with HHMI appointment is not due to a causal effect of status spillovers, but rather to a selection bias imposed during the assignment to treatment.

We undertook several analyses to understand the influence of field heterogeneity. To examine relative field size, we retrieved the PMRA sets for each treated article and random, same-journal-issue control paper, and we tabulated field sizes at treatment. On average and before further filters, the treated Neighbor Articles are related to 125.8

articles, while the Control Articles are PMRA-related to somewhat fewer papers, 102.6 (see descriptive sections in column 1 of Table 7). Therefore, treated articles exist in fields that are almost 25% larger than control fields. To eliminate this source of field-level heterogeneity from the results, we identified same-journal-issue control articles that match on PMRA field size counts using coarsened exact matching. When we estimate the treatment effect while matching on field size, the average treatment effect remains negative and statistically significant (-0.061).

We also created two measures of field maturity to compare the scientific fields of treated and control articles. First is the time elapsed since the earliest, PMRA-related paper was published in the field. Second is the average age of the MeSH keywords assigned to the papers in each field. Examining levels of these variables for our original estimation sample (see column 1 of Table 7), we see that the treated and control articles occupy fields of "age" 20.104 and 21.170 years, respectively, with "MeSH vintage" of 34.079 years and 35.258 years. If anything, our original control fields are very slightly more mature than treated fields. The results are robust in CEM regressions that select control articles to match on the field maturity measures.

Finally, we re-assembled the data panels in a very different manner. We identified a group of scientists that, (i) completed their terminal degree at the same time as the HHMI appointees, and (ii) that had accumulated similar counts of career citations by the time of the HHMI's appointment. Next, we retrieved the publications of this group of "pseudo-HHMIs" that appeared during the same period as our HHMI-authored source articles. Third, we retrieved the papers related to these "pseudo-HHMI" source articles. Then, for each HHMI Neighbor article, we selected a same-journal-issue control article that was a member of this superset of pseudo-HHMI related papers.

Descriptive statistics for these panels appear in column 4 of Table 6 . As can be seen in the table, if anything, the "pseudo"-HHMI-related papers are from fields with more activity than HHMI-related papers (146.613 related papers compared with 131.856 for HHMI-related papers). Again, we find that the average treatment effect estimated with these panels is consistent with a competition effect.

In all, across multiple reconstructions of the control group, we find robust evidence of negative status spillover effects.

DISCUSSION AND CONCLUSIONS

We hope this article motivates a new focus for 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.

The allocation of attention generally is driven by two questions: "Which domain?" and "Which actor or product in a given domain?" These questions correspond to Zuckerman's (1999) two-stage, "categorical imperative" model: audiences first consider whether objects conform to a given, cognitive category, and then assess the differences among objects deemed members of the consideration set. The categorical imperative may be generalized to conditions in which the categorical options are not known a priori: in many areas of creative endeavor, producers and consumers often find themselves considering what domain(s) to enter next, including areas that they have attended to previously. In the context we study, prizes in the biomedical sciences, the allocation of effort is the outcome of a search across a set of interconnected set of fields and then a choice about a specific point of entry within a field. This process constantly unfolds, as researchers initiate new projects and as they pivot the direction of existing ones.

Our findings suggest that positive status shocks, perhaps counterintuitively, invoke categorization processes that can adversely impact the fates of those in the neighborhoods of winners' areas of endeavor. We find that the bestowal of a prestigious prize generally dampens attention to the winner's area of activity relative to the counterfactual citations trends established by articles in control fields. One explanation is that prizes render neighborhoods synonymous with the activity of prizewinners. While this may solidify categorical boundaries, a potential consequence for attention-allocating audiences is a narrowing of perceived entry criteria, thus limiting follow-on activity in the domain. A variation of this that is especially intriguing in scientific contexts is that a prize may transform a previously contested terrain to a more clearly undisputed one, and in the process, define canonical works that become de facto references for an idea. With decreased entry into the neighborhood and decreased variation in what outside audiences attend to, aggregate attention to the area actually atrophies relative to a counterfactual (to the awarding of the prize) trend.

In technical, scientific, and cultural markets, we know that a core function of prizes is to contour the allocation of producers' efforts and audience members' attention. The literature shows that prizes and other markers of prestige adjust the focal points of participants in these markets. But we argue that a narrow view of prizes misses their full ecological consequences, in which recipients' bumps in status diffuse throughout the neighborhoods of their endeavors. We generally find that in this diffusion, competition swamped endorsements. We present 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.

In assessing these results, it is vital to bear in mind that the experiment we run is unlike prior research on the subject. The treatment effect in our paper is not the effect of the prize on the winner's work; it is the effect of the prize on the fates of the pre-existing (at the time of bestowal) output of the winner's neighbors. Likewise, the yardstick against which the fates of these treated articles are computed is not based on prizewinners 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 prizewinners 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 we find that status shocks generally induce an aggregate, negative spillover to the neighbors of a prizewinner, 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).

A distinct aspect of our empirical context is the fact that the actors producing content and those bestowing recognition (in the form of citations) are one and the same. In other words, scientists are both the producers and consumers of research. It is worth considering whether the finding of the dominance of competition over endorsement would hold in settings without an "audience of experts"? We can only speculate, but theory suggests that if anything, the results should be dampened in contexts in which experts sit on both sides of the market, as they do in academe. Relative to general audiences, scientists-as-expert consumers should be adept at judging the underlying quality of research, and thus should be less susceptible to social distortions in their judgments of merit. In other words, we imagine that comparable tests of the magnitude and spillover effects of status in theory should be larger in markets in which consumers of a good have less expertise than producers. Consistent with this view, Heinich (1999) offers a theoretical comparison of the impact of artistic and scientific prizes. She considers prizes to be critical in both domains, but because of the enormous uncertainty around value in artistic fields, prizes in literature and the arts are potentially much more significant in their effect than awards of equivalent prestige in science.

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 vast quantities of works are created in art and architecture and cinematography. If these titanic bodies of work are like large seas, the effect of a scarce, status-creating prize is like dropping a rock in the sea. The accolade influences the career of its recipient for sure, but the prize also create a splash in one area—a scientific field in our project—and its effect then ripples across adjacent areas of work . We believe that to truly understand the ecological effects of the status dynamics of prizes, it may be necessary to observe the entire sea. In short, the questions we pursue in this project require researchers to confront the classic social scientific challenge of a micro-to-macro linkage to truly understand the full ecology of a status effect in markets. We believe that the broader questions of how status shocks affect social, scientific, economic, and cultural communities remain 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	1992.331	5.181	1993	1984	2003
Year of Highest Degree	1980.662	7.571	1981	1956	1998
Career Age at Appointment	11.669	6.228	10	0	36
Female	0.191	0.394	0	0	1
Nb. of Source Articles	4.583	3.467	4	1	19
Career Publications	46.793	42.967	33	1	285
Career Citations	5849.966	6975.520	3862	111	90245
Nb. Publications in Top 1 Percent of Citations	8.276	8.499	6	0	74

N HHMIs = 393. 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	1990.911	5.076	1991	1982	2002
Number of Authors	4.018	2.132	4	1	15
Publication Age in Year of Appointment	1.481	0.500	1	1	2
Total Forward Citations through 2007	159.012	320.325	83	0	8145
Total Fwd. Cit. (Cohort Percentile)	86.346	18.678	94	0	100
Journal Impact Factor	8.976	7.144	6	0	30
Total Nb. of Neighbor Articles	26.805	32.058	19	1	741

N HHMI Articles = 1,801 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 = 23,336)			Control Articles (N = 23,336)			Overall	
	Mean	Std. Dev.	Median	Mean	Std. Dev.	Median	Min.	Max.
Publication Year	1987.491	5.941	1988	1987.491	5.941	1988	1974	2000
Number of Authors	3.830	2.127	3	3.785	2.108	3	1	65
Journal Impact Factor	5.364	5.180	4	5.364	5.180	4	0	30
Article Age in Year of Appointment	5.704	2.115	5	5.704	2.115	5	3	10
Stock of Citations at Appointment	26.238	57.393	11	20.191	47.164	8	0	2654
Total Citations Accumulated by 2007	63.728	174.068	26	50.892	110.692	21	1	16193
Total Fwd. Cit. (Cohort Percentile)	73.818	23.434	81	70.796	23.790	77	13	100
Has Any Author of HHMI Source Article	0.068	0.251	0	0.001	0.036	0	0	1
Has Collaborator of Focal Source Author	0.138	0.344	0	0.015	0.122	0	0	1
Cited by Source Article	0.121	0.326	0	0.001	0.024	0	0	1
PubMed Relatedness Score	0.581	0.144	1	.	.	.	0	1

N Articles = 46,672. 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	-0.072**	-0.025	-0.097**	-0.095**	-0.073**	-0.118**	-0.113**	-0.192**
	(0.020)	(0.034)	(0.018)	(0.017)	(0.022)	(0.020)	(0.027)	(0.024)
Treated × Top 50% PMRA Score		-0.085*						
		(0.040)						
Treated × Shares an Author with Focal HHMI Source			0.198*					
			(0.095)					
Treated × Has Pre-Appt. Collaborator of Focal HHMI				0.174†				
				(0.102)				
Treated × Has Post-Appt. Collaborator of Focal HHMI					0.002			
					(0.039)			
Treated × Cited by Focal HHMI Article						0.149**		
						(0.047)		
Treated × HHMI Article Field in Lower 50% of Citations per Article at Baseline							0.157**	
							(0.041)	
Treated × HHMI Article Field in Lower 50% of Mean JIF at Baseline								0.304**
								(0.050)
Nb. HHMI Investigators	393	393	393	393	393	393	393	393
Nb. of HHMI Source Articles	1,801	1,801	1,801	1,801	1,801	1,801	1,801	1,801
Nb. of Related/Control Articles	46,672	46,672	46,672	46,672	46,672	46,672	46,672	46,672
Nb. of Article-Year Obs.	957,176	957,176	957,176	957,176	957,176	957,176	957,176	957,176
Log Likelihood	-1,316,345	-1,316,042	-1,315,598	-1,315,751	-1,316,345	-1,315,539	-1,315,541	-1,312,626

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. In Model (2), treatment is interacted with an indicator that among all papers related to the focal HHMI Source Article, the Neighbor Article has a PubMed Related Article (PMRA) score in the top 50%. Interactions in Models (3) through (5) pertain to authorship of the HHMI-related paper. In Model (3), 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 (3) is identified using matching last names and first initials. Interactions in Models (4) and (5) 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 (6), treatment is interacted with indicators that the Neighbor Article was cited by the HHMI-authored source article. Models (7) and (8) include interactions between treatment and indicators that the HHMI Source Article is in a PMRA field in the lower 50% of (a) mean forward citations accrued to related papers by appointment, and (b) mean journal impact factor (JIF) of the related papers' journals. Exponentiating coefficients and subtracting from one yields numbers interpretable as elasticities. For example, on average, Neighbor Articles experience a 6.976 percent (1-exp(-0.072)) 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

	(1) Nb. Citations	(2a) Nb. Citations (Within-Field)	(2b) Nb. Citations (Out-of-Field)	(3) Percent MeSH Overlap with Citing Papers
Treated	-0.009	-0.242**	-0.050*	-0.003**
	(0.036)	(0.022)	(0.021)	(0.001)
Treated × HHMI Article in Top 50% of Citations in Year after Appt.	-0.132**			
	(0.048)			
Nb. Focal Scientists	393	393	393	393
Nb. of Source Articles	1,801	1,791	1,791	1,801
Nb. of Related/Control Articles	46,672	38,941	38,941	46,591
Nb. of Article-Year Obs.	957,176	795,248	795,248	547,900
Log Likelihood	-1,315,609	-449,904	-1,122,857	691,790
H_0: $\text{Treated}_a \geq \text{Treated}_b$ p-value		0.000**		

Note: Estimates stem from conditional quasi-maximum likelihood Poisson or maximum likelihood specifications. All models incorporate a full suite of calendar year effects, and article age fixed effects. Article age is computed relative to the publication year. For Models (1) through (2b), the dependent variable is the total number of forward citations (excluding self-citations) received by each related or control article in a particular year. In Model (1), treatment is interacted with an indicator that the HHMI Source Article is in the top 50% of (positive) change in citations between the pre-appointment and post-appointment period. 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. The dependent variable for Model (3) is the average percent of Medline Subject Heading (MeSH) keyword overlap between a treated or control paper and their citing papers. Parameter estimates for this model are obtained through ordinary least squares regression. Results of a one-sided Wald tests comparing treatment estimates in Models 2a and 2b are reported.

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

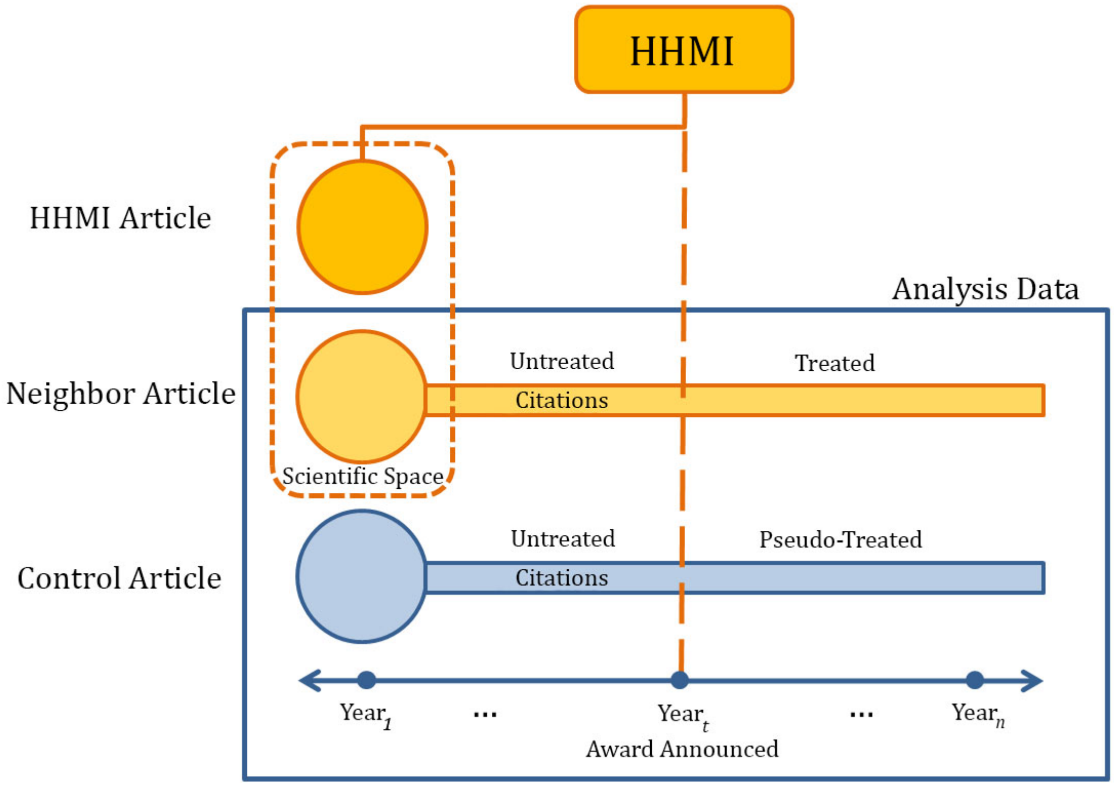
Table 6: Descriptive Statistics and Prize Effect Estimates under Various Control Selection Regimes

	(1) Same-Issue Random Controls		(2) Same-Issue, Coarsened-Exact Matching: Stock of Citations		(3) Same-Issue, Coarsened-Exact Matching: Stk. Rltd. Papers		(4) Same-Issue, Pseudo-HHMI-Rltd. Controls	
	Nghbr.	Control	Nghbr.	Control	Nghbr.	Control	Nghbr.	Control
Stock of Citations	26.238	20.191	24.930	24.627	26.453	21.556	29.021	29.449
	(57.393)	(47.164)	(52.399)	(55.556)	(56.182)	(48.766)	(58.624)	(61.359)
Stock of Related Papers	125.843	102.557	127.062	104.283	116.422	114.761	131.856	146.613
	(135.393)	(101.043)	(135.177)	(100.564)	(117.468)	(106.886)	(145.534)	(172.834)
Years Since Earliest Rltd.	20.104	21.170	20.028	20.516	19.825	21.079	19.453	19.453
	(10.242)	(10.535)	(10.186)	(10.258)	(10.070)	(10.147)	(9.925)	(9.719)
Avg. MeSH Keyword Vintage	34.079	35.258	34.002	35.020	33.991	35.047	33.654	33.910
	(5.633)	(5.867)	(5.607)	(5.691)	(5.596)	(5.708)	(5.331)	(5.063)
Treated	-0.088**		-0.087**		-0.061**		-0.063*	
	(0.018)		(0.022)		(0.021)		(0.029)	
Nb. Focal Scientists	399		392		393		392	
Nb. of Source Articles	1,950		1,774		1,768		1,711	
Nb. of Articles	64,102		41,756		40,712		32,754	
Nb. of Article-Year Obs.	1,263,764		854,760		834,066		659,030	
Log Likelihood	-1,776,835		-1,235,308		-1,168,802		-1,041,342	

Note: Means and standard deviations (in parentheses) of 'field' variables are reported separately for HHMI-Related Neighbor Articles and Same-Issue Controls. Variables are aggregated up to the year immediately preceding the relevant HHMI appointment announcement. All models were estimated with panels using same-issue controls, but panels differ in how these controls were selected. For Model (1), each Neighbor Article was paired with a randomly selected Control Article from the same issue of publication. For Model (2), same-issue controls were matched to Neighbors on stocks of pre-appointment citations using coarsened exact matching. For Model (3), each Neighbor was matched with a same-issue control on stocks of related papers using coarsened exact matching; related papers were identified using the PubMed Related Articles algorithm (PMRA), the same process used to identify papers related to HHMI source articles. For Model (4), same-issue controls were selected from the super-set of articles related to a 'pseudo-HHMI' scientist, one who completed their terminal degree at the same time as an HHMI scientist and accumulated a similar stock of career citations by the time of the HHMI's appointment. 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 HHMI-related Neighbor Article or same-issue Control Article in a particular year. All models incorporate a full suite of calendar year effects and article age fixed effects. Article age was computed relative to the publication year. Exponentiating coefficients and subtracting from one yields numbers interpretable as elasticities. For example, under the random same-issue control selection regime, on average, Neighbor Articles experience a 8.450 percent 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 below prize effect estimates.

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

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

1. Identify HHMI investigators

hhmi

Katherine A. High, MD

Appointed HHMI Investigator in 2003

2. Retrieve HHMIs' pre-appointment publications (HHMI Articles)

Biochemistry. 2000 Nov 21;39(46):14322-9.

Enhanced gamma-carboxylation of recombinant factor X using a chimeric construct containing the prothrombin propeptide.

Camire RM[1], Larson PJ, Stafford DW, High KA.

3. Retrieve articles related to HHMI Articles (Neighbor Articles)

Related citations in PubMed

→ Role of the propeptide and gamma-glut: [Biochemistry. 1998]

In vitro gamma-carboxylation of a 59-residue [J Biol Chem. 1990]

Review The vitamin K-

4. Identify same-issue controls for each Neighbor (Control Articles)

Biochemistry. 1998 Sep 22;37(38):13262-8.

Role of the propeptide and gamma-glutamic acid domain of factor IX for in vitro carboxylation by the vitamin K-dependent carboxylase.

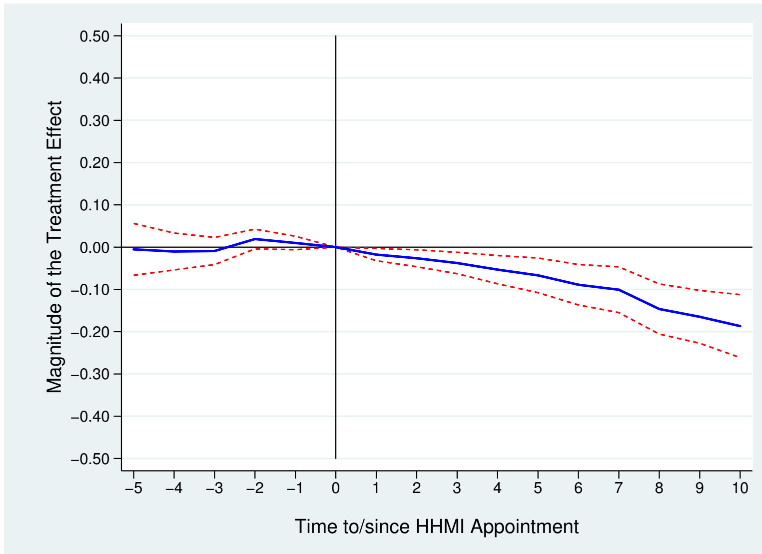
Stanley TB[1], Wu SM, Houben RJ, Mutucumarana VP, Stafford DW.

Biochemistry. 1998 Sep 22;37(38):13184-93.

Mechanism-based inactivation of cytochrome P450 2B1 by 8-methoxypsoralen and several other furanocoumarins.

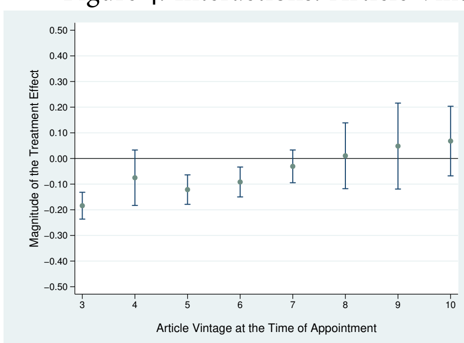
Koenigs LL[1], Trager WF.

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

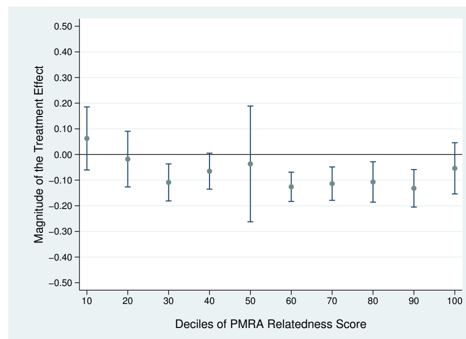


Note: The solid blue lines correspond to coefficient estimates from conditional fixed effects quasi-maximum likelihood Poisson specifications in which the citation rates for Neighbor Articles and Control Articles are regressed onto year effects, article age indicator variables, as well as interaction 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.

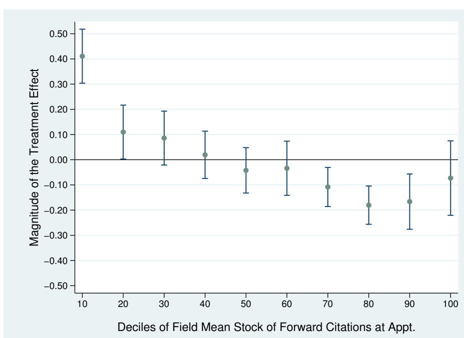
Figure 4: Interactions: Article Vintage, Relatedness, Field Size, Field Status



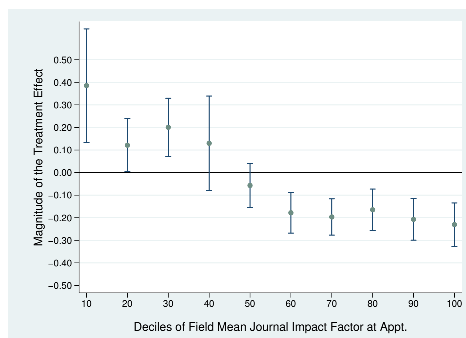
(a)



(b)



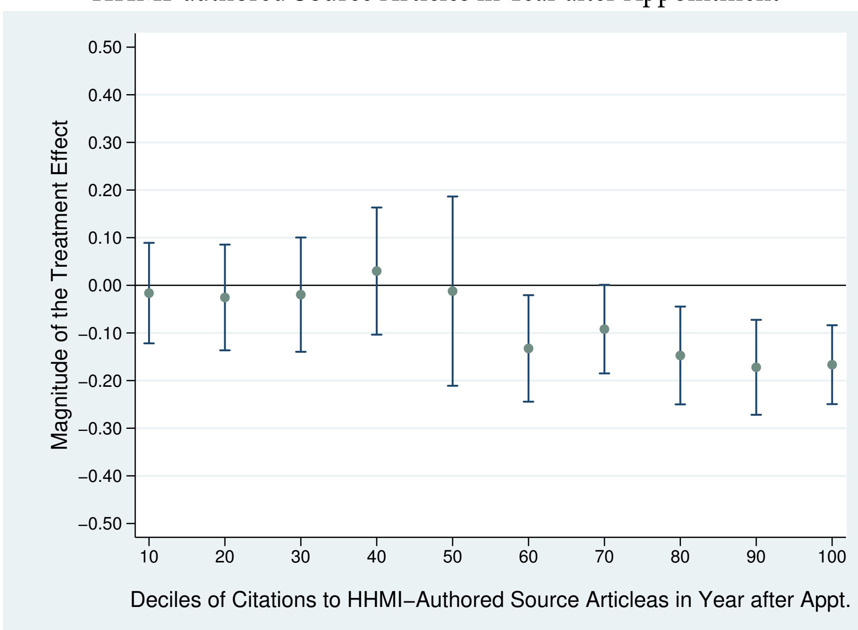
(c)



(d)

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 one of the following: (a) the vintage of Neighbor Articles at the time of the HHMI appointment; (b) deciles of the PMRA relatedness score; (b) treatment status and deciles of the change in citations to the relevant HHMI-authored Source Article, before and after HHMI status is announced; (c) deciles of the PMRA field's mean stock of forward citations, accumulated by appointment; or (d) deciles of the field's mean journal impact factor, accumulated by appointment. The blue bars represent 95% confidence intervals corresponding to robust standard errors, clustered around HHMI investigators. Since HHMI Articles are published one or two years before appointment, and Neighbor Articles are published at least two years before HHMI Articles, the interaction terms in panel (a) range from 3 to 10 years prior to appointment.

Figure 5: Interaction between the Treatment Effect and Deciles of Citations to HHMI-authored Source Articles in Year after Appointment



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 deciles of the change in citations to the relevant HHMI-authored Source Article, before and after HHMI status is announced. Since HHMI Articles are published one or two years before appointment, and Neighbor Articles are published at least two years before HHMI Articles, the interaction terms range from 3 to 10 years prior to appointment. The blue bars represent 95% confidence intervals corresponding to robust standard errors, clustered around HHMI investigators.