

## **PERSONAL STATEMENT**

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My research agenda examines the conflicts and compromises shaping the boundary between academic science and the commercial world -- especially those wrought by substantial growth in the enforcement of intellectual property (IP) rights over basic scientific research. In particular, while the expansion of IP rights provides many opportunities for science-based firms and universities to commercialize science, it may also transform the broader scientific community in unexpected ways, with surprising implications for the long-run accumulation of scientific knowledge. Understanding these tensions is of great significance for individuals, firms and nations intending to use science as a source of competitive advantage.

To address these critical issues, my research deepens our understanding of the academic-commercial boundary. Not only does it describe the broad transformation wrought on scientists by IP. It also identifies the causal impact of this transformation in two areas: the daily life of scientists and the productivity and organization of the scientific community. Finally, it captures the mediating influence of firm strategy and social norms on these changes and, reciprocally, the ways in which academic scientists and their counterparts in industry have shaped their institutional environments. In doing so, my work expands our current understanding of how changes in IP rights and their enforcement shape the daily practices of scientists and in turn how this influences the organization and productivity of scientific work. It also brings new insights into the ways in which scientists actually shape their institutional environments, contrasting the relatively simplistic view of the scientific community that prevails. As a result of my research, scholars, managers and policy-makers are better able to predict how their strategies and policies shape and are shaped by scientific practice, and therefore how they influence knowledge accumulation and, ultimately, growth.

My research is inherently interdisciplinary, drawing on insights from sociological, economic and management theory and bringing them closer to science as practiced "on the ground". In doing so, I contribute to (and challenge) scholarly conversations in these fields while also deepening our overall understanding of scientific work. The approach I take to this interdisciplinary challenge is unique in the way it combines my scientific background and personal experience of scientific life with the scholarly literature across diverse fields of enquiry. As a consequence, my work is characterized by careful analytic

designs that exhibit a deep understanding of similarities and differences across scientific fields of enquiry and a precise knowledge of the details of specific policy changes as they are experienced by scientists. It is also unusual because I implement these approaches in both qualitative and quantitative studies, often taking insights derived from qualitative work to inform new quantitative studies and vice versa. The promise of my approach is to offer rich insights into the link between scientific and commercial institutions on the one hand and the productivity and practices of scientists on the other.

Influential scholars in several disciplines have recognized the value of my work. It has made important theoretical contributions to economics, sociology and the management of intellectual property. In addition, it has influenced public policy debates on the pros and cons of intellectual property (particularly in academia), providing new empirical evidence as well as methods that can be applied to other issues in science policy. Lastly, scholars have noted the strong managerial implications of my work for how firms manage intellectual property and build relationships with scientific communities. The broad and diverse influence of my work has been validated by the range and prominence of my funding sources and publications. My support ranges from a Sloan Foundation Industry Fellowship to a National Science Foundation “Science of Science Policy” grant, and my articles are published in places such as *Science*, *The New England Journal of Medicine*, *American Journal of Sociology*, *Organization Science*, *Journal of Economic Behavior & Organization* and *Research in the Sociology of Organizations*.

Before describing the three streams of my research it is important to articulate the theoretical grounding of my research and how it bridges several fields of enquiry: sociology of science and scientific institutions, economics of science and innovation, and management of intellectual property. My work proceeds in the spirit of accumulation and I find myself standing on the “shoulders of giants” in each of these fields. Nonetheless, while each field brings its own perspective to the questions I ask, they proceed largely independently and operate under important limitations that my work aims to overcome. On the one hand, traditional sociology of science (and of other knowledge communities) has articulated the institutional system guiding researchers and, in more recent years, examined the detailed features of daily scientific life. However, this literature stops short of analyzing how institutional change leads to changes in the productivity, social structure or organization of knowledge work. Nor has it broadly examined the role of other institutional elements that affect the scientific community; most notably, studies of the scientific community are silent on the role of legal institutions (including but not limited to IP rights). Scholars who study the economics of science and innovation attend to the institutions undergirding innovation but focus mainly on the patent system as it influences firm knowledge production. They pay less attention to analyzing changing scientific institutions, changes at the science-commerce interface (such as patenting in academia) and the impact of these changes on the rate and direction of scientific knowledge accumulation. The third relevant field that my work bridges, intellectual property strategy, typically takes the rules of the patent system for granted and rarely examines when and how individual

researchers (in academia or industry) attempt to change the patent system and its attendant property rights. The field also overlooks what happens how firm strategies interact with public knowledge production and the knowledge communities upon which they rely.

The major goal of my work is to illuminate these fields in a way that brings theory into deeper connection with scientific practice, and to reveal the important roles that working scientists play at the academic-commercial boundary. While most research in this field relies upon bibliometric data alone, my work is distinguished by detailed study of scientists combining extensive interviews with bibliometric data and statistical analysis. I have found that my training as a scientist provides excellent preparation to fulfill this challenging task. First, it enables me to gain unusual access to members of the scientific community, and to explore the nuanced ways in which institutional changes shape their detailed research choices, research direction and disclosure choices. For example, when interviewing mouse geneticists about the impact of the Oncomouse patent (owned by Harvard and licensed to DuPont) on genetically engineered research mice, I was able to probe deeply into the ways in which DuPont's patent licensing terms shaped their experiments, their labs and their communities (Murray 2008ab). My interviews with male and female scientists on issues of gender and commercial science were also facilitated by my own laboratory experiences (Murray & Graham 2007; Ding, Murray & Stuart 2007, 2008). Second, I use my knowledge of scientific practice to articulate a more precise description of how scientists behave, which leads to theoretical and empirical insights. My determination that scientific knowledge was often disclosed as patent-paper pairs drew on my own time in the laboratory and my interviews with leading scientists at MIT and beyond (Murray 2002). Third, my scientific knowledge allows me to develop new sources of data and natural experiments (Murray & Stern 2007): developing a landscape of the disclosure of all 25,000 human genes (in terms of the patents, publications and patent-paper pairs), I combined bioinformatics and bibliometric methods (Jensen & Murray 2005, Huang & Murray 2008, Gans, Murray & Stern 2008). More recently, I used my understanding of genetics to analyze over 13,000 research mice identifying those affected by changing IP-enforcement conditions as well as two control groups, unaffected by the change (Murray et al. 2008). This type of analysis requires an understanding of the subtleties in scientific fields.

## **MAPPING RESEARCH THEMES**

The expansion of IP rights in the past twenty five years, particularly in the life sciences, increased opportunities for scientists to file patents. This is considered to be both a source of scientific (and commercial) competitiveness, but also of concern. Scholars and policy-makers debate the potential impact of IP on academia – on the level and direction of scientific progress as well as the social organization of scientific communities. Contributing to these vigorous debates, I have grounded my work in the observation that scientists increasingly file patents and publish papers on the results of their

scientific experiments (Murray 2002). While traditionally thought of as arising from two distinctive types of research investments, a central part of my research argues that a single research project can generate outputs that simultaneously contribute to public knowledge and to commercialization. Consequently, researchers can make a variety of disclosure choices. Depending on their preferences and institutional positions, scientists can publish, file patents, or do both. A single example from my research is instructive. In 1984, Harvard researchers developed the first transgenic mouse susceptible to cancer – the Oncomouse. Their decision to disclose as a "paper-patent" pair highlights its value as a scientific discovery and a commercial product. It also embeds the same knowledge in two distinctive institutional logics – the logic of the public commons most closely associated with academic science and the logic of private property, traditionally linked to commercial science. The choice made by the Harvard scientists is not a peculiar anomaly. In fact, my research shows that pairs often constitute the preferred disclosure choice of researchers in academia and industry: in “The Intellectual Property Landscape of the Human Genome” (Jensen & Murray 2005) we find that over 20% of genes in the human genome are patented. Of these, at least 85% are disclosed as patent-paper pairs (Huang & Murray 2008).

Patent-paper pairs provide a lens for a broader examination of the intersection between the institutions of the public commons and private property. When knowledge is disclosed in patent-paper pairs it initiates a set of dynamic processes that bring these two institutions into convergence. At the same time, because the normative requirements of these public and private institutional logics may diverge, this intersection can, at times, conflict. My work examines this intersection in three ways, which I describe below as three streams: First I articulate the conditions shaping how individual scientists select their disclosure strategies, focusing particularly on the influence of their organizational settings (academia versus industry). Second, I explore how scientists come together to challenge and adapt to some of the unintended consequences and conflicts at the boundary of these public and private institutions. Third, I develop and apply quantitative methods to capture how IP affects scientific productivity and the social organization of the scientific community.

### **Stream I: IP and the Individual Practices of Scientists**

I argue that the decisions of scientists to embed their knowledge in the public commons (papers) or private property (patents) institutions are endogenous. This challenges the prevailing view of scientific progress – a view claiming that a clear, exogenous mapping can be made from the institutional logic of disclosure to both the type of knowledge and the organization of its production. According to this account, basic knowledge produced in academia is disclosed in the public institutional sphere, while applied science is produced by for-profit firms and disclosed through patents. In challenging this view, two of my papers explore the ways a researcher’s organizational setting contours her disclosure choices:

**Academic scientists.** My research on patenting decisions in academia highlights important gender differences in faculty patenting rates. While the rewards for researchers in the life sciences are still largely based on publications, they also receive some (limited) commercial returns to patenting and other forms of commercial science (Edwards, Murray and Yu, 2006). Even when financially unsuccessful, commercial science provides additional scientific resources. For example, in “Buying Science & Selling Science: Gender Stratification in Commercial Science” (Murray & Graham 2007), my interviews with more than 100 faculty members show that participation in commercial science brings with it distinctive forms of status and resources and that patents have become an integral part of faculty strategies for the dissemination of ideas and for signaling interest in commercial activities. Given the value of patenting, it is puzzling to find that wide variation in patenting rates exists even after controlling for the inherent “patentability” of research. This suggests that the decision to disclose through patent-paper pairs is mediated by complex social factors in academia.

I pursue this question in “An Empirical Study of Gender Differences in Patenting among Academic Life Scientists” (Ding, Murray & Stuart 2006). Our analysis shows that for over 4,000 life science faculty, after accounting for the effects of productivity, networks, field, and employer attributes, the net effect of gender remains: women patent at 40% the rate of comparable men. We establish several additional qualitative findings: women believe patenting to be complex, and lacking rich commercial networks, they also believe that patenting is time consuming and unlikely to be fruitful. Unlike their male counterparts, women expressed concern about the potentially negative impact that patenting might have on education, collegiality, and research quality. On a more positive note, the archival data suggest that the gender gap is decreasing, and the institutional environment for patenting is changing (thus changing the meaning of patents, as I describe below). These findings have generated considerable interest among policymakers, the Association of University Technology Managers and scientists themselves.

**Industry scientists.** In a new working paper “Patents, Papers, Pairs & Secrets: Contracting Over the Disclosure of Scientific Knowledge” (Gans, Murray & Stern, 2008) I examine the disclosure choices of researchers in industry. We argue that four disclosure regimes are considered in industry: secrecy, patenting (commercial science), publication (academic science) and patent-paper pairs. The disclosure decision, we claim, is grounded in the negotiation between researchers and the firms who fund their research. By developing a simple economic framework to describe these negotiations we map the precise conditions under which each disclosure choice is likely to dominate. At the most simple level, we argue that researchers want to publish to gain recognition (like their academic counterparts) but funders want to retain the knowledge as a secret (at odds with publication) or to use patent protection as a barrier to entry. Thus, there is complementarity between patenting and publishing because, once patents are filed, if disclosures in patents and papers overlap then the marginal cost of publishing falls and patent-paper pairs dominate. This perspective provides a simple but instructive model to explain patent-paper pairs and

raises questions about a set of strategically important economic choices that are more typically treated as empirical puzzles. It is also useful for exploring the institutional foundations of knowledge production, providing the micro-foundations for understanding knowledge disclosure.

## **Stream II: Scientific community shapes IP**

Studies of disclosure by individual scientists simply take the public and private institutional logics as given. The diverging norms in these two institutional spheres, however, suggest that across the broader scientific community, patent-paper pairs may be as much a source of conflict as an unproblematic opportunity for multiple forms of rewards. I have explored this important issue in a number of papers focusing on the ways in which IP rights are transformed by the researchers in the academic community, and by entrepreneurs engaged in commercial science.

**Academic Transformation:** In The Oncomouse that Roared: Hybrid Exchange Strategies as a Source of Productive Tension at the Boundary of Overlapping Institutions (Murray 2008), I examine the ways in which patents shaped and were shaped by the mouse genetics community. I take as my centerpiece the publication and patenting of the Oncomouse: the first example in mouse genetics of the embedding of a single piece of knowledge in two institutional logics. The paired disclosure initiated a dynamic process for the exchange and follow-on use of oncomice (and their techniques of production). For 3-4 years, the mice were subject only to the informal norms for exchange and follow-on use characteristic of a competitive, but collegial, scientific community. After the grant of the patent, DuPont (exclusive licensee) strongly enforced its property rights on scientists. Through detailed interviews and documentary analysis comparing the pre- and post- patent period, I closely analyzed the impact of the Oncomouse patent on mouse geneticists and how they sought to shape the enforcement and meaning of IP rights. I document the outrage felt by scientists over DuPont's licensing conditions (which included fees, limits to informal exchange, pre-publication research disclosure and reach-through rights) and their objections on practical, historical and philosophical grounds.

In response, some scientists reluctantly acquiesced, dealing with complex contracts. Others defied DuPont, sharing mice informally in the face of opposition from their universities. Compromise emerged a decade later when the NIH persuaded DuPont to sign a Memorandum of Understanding making Oncomice open for experimentation (a contract I analyze in Murray et al. 2008). Behind the scenes other more complex changes were also taking place as scientists sought to reshape the meaning of patents in their daily life. They used patents in new ways: i) To delimit a protected arena for academic science, by inhibiting the ability of commercial actors to dominate the ways in which patented ideas could be used, ii) to redefine the terms of commercial-academic interchange forcing closer attention to inventorship and authorship, and iii) as incentives to transfer research tools into industry in the hope that they would be more widely available in academia.

At the broadest level, my Oncomouse research contributes to our understanding of boundaries where institutional logics overlap and conflict, explaining what happens when practices from one institution (patents) cross the boundary and encroach into another institution (universities). My work highlights the active role of scientists in maintaining the distinction between academic and commercial science, doing so by taking the resources of the commercial logic (patents), transform their meaning and establishing hybrid exchange strategies. Thus, contrary to the current literature, I argue that hybrids can emerge from conflict, exist in productive tension and are produced through boundary work to redefine but maintain the distinction between two logics. The findings and theoretical insights from this study challenge the existing literature in several fields: Scholars arguing that the normative order of academic science is a slender reed, easily overcome by the forces of commercialization, have reconsidered their views. Similarly those who suggest that science is unchanged must also consider the active and changing role of researchers in the scientific community. While it is true that patenting among academic scientists did increase in this period, many mouse geneticists used patenting to maintain their boundary with commercial science not blur it.

An important related lesson I take from the Oncomouse case and elaborate in "Patenting Life: How the Oncomouse Patent Changed the Lives of Mice & Men" (Murray 2008b) is the power of individuals, communities and institutions to shape meaning. Patents are social constructions forged in the realm of commercial science. When patents are transplanted into the realm of academic science, the context shifts and, I show, their meaning is changed. Academic scientists adopted the practice but not all its commercial implications. Patents became more than a source of financial reward, evolving instead into a source of kudos and resistance but also collaboration and currency. This suggests that we consider the complex and subtle ways in which academics have transformed both the practical and symbolic nature of patents and incorporated them as powerful elements in their daily life.

**Industry Transformation.** Entrepreneurs also shape patents and the institutional logic of private property as they seek to shape IP in support of commercial science. I characterized these transformations in "Entrepreneurs, Institutions and the Construction of Value in Biotechnology" (Kaplan & Murray 2008) -- an historical analysis of the biotechnology industry focused on the role of entrepreneurs in transforming institutions to construct value. My work shows that while entrepreneurs in the early-stages of the industry did not attempt to broadly transform the meaning of IP rights, they did seek to shape the scope, strength and perception of patents. Their strategies included *amicus briefs* in key Supreme Court cases (e.g. *Diamond v. Chakrabarty*), testimony in patent reform (e.g. utility requirements for gene patents), as well as direct patent litigation. The broad aim was to reinforce the role of IP and appropriability as one pillar of economic value in the commercialization of biotech. The success of entrepreneurs in convincing judges and policymakers to allow patents on genetically modified bacteria (for the production of drugs),

on genetically modified mammals (such as the Oncomouse), on gene sequences and even on stem cells has transformed the nature of entrepreneurial firms and their commercial strategies.

My research on the role of entrepreneurs and academic scientists shaping patents has contributed to the literature on institutional change. At a more micro-level, it provides a deeper understanding of the mechanisms that shape the uncertain nature of IP, thus contributing to our understanding of the causes and consequences of appropriability. By taking IP rights as malleable and endogenous to the strategies pursued by entrepreneurs and scientists -- instead of the traditional view, which takes IP as given and exogenous -- we can better understand the institutional foundations of the knowledge economy.

### **Stream III. IP & Public Knowledge Accumulation**

Scientists (together with firms, judges, university administrators, and others) shape the ways in which the public and private institutional logics interact, and the meaning of patents and papers in these interactions. Consequently, as the Oncomouse study shows, when institutions generate rules that enable knowledge to be embedded in patent-paper pairs, (potentially conflicting) relationships form with follow-on researchers who hope to build cumulatively on this knowledge. The role of patents in these exchanges and the differences in the institutional logic of private property compared to the open commons, has sparked scholars (particularly economists and legal scholars) to debate whether patents diminish contributions to public domain by follow-on researchers. The notion is that scientists, like mouse geneticists, are deterred by arduous licenses (or the threat of ex post IP enforcement). In my quantitative work, I examine these claims using novel empirical data and methods: I estimate the casual impact of patent grant, enforcement and changes in IP-access contracts on cumulative innovation, specifically knowledge disclosed through follow-on publications (rather than patents). Two key results suggest that the long-run production of public knowledge is highly sensitive to shifts in the openness of key early-stage knowledge inputs:

- i. Grant of the paired patent (a shift to lower openness) decreases follow-on innovation, particularly for public-sector researchers responding to private sector patents.
- ii. Contractual agreements shifting knowledge to greater openness (contracts lowering the level of patent enforcement), increases follow-on innovation.

The first of these papers, "Do Formal Intellectual Property Rights Hinder the Free Flow of Scientific Knowledge?" (Murray & Stern 2007) establishes the novel empirical basis of this approach. We exploit two characteristics of patent-paper pairs: First, we show that over 50% of publications in *Nature Biotechnology* are disclosed as patent-paper pairs. Second, patents are granted with a 3-4 year lag with follow-on accumulation taking place in two distinct environments; the pre-grant period where informal norms hold and the post-grant period when IP rights can be enforced. Using a differences-in-

differences estimator we find a 10-20% decline in the citation rate to the paired publication after patent grant. A controversial finding, this evidence has been incorporated into National Academies of Sciences reports and is the subject of ongoing scholarly discussion. (The paper has been cited over 100 times).

While these results are suggestive, in an argument developed in “Exploring the Foundations of Cumulative Innovation” (Murray & O’Mahony 2007), I posit that three conditions shape knowledge accumulation: disclosure, access and rewards, with each being shaped at the institutional, community and organizational levels. Simply put, while patents may shape follow-on innovators, their influence is likely to be contoured by the organizational strategies of patent holders (or their licensees), the social context of follow-on innovators (i.e. whether they are in academia or industry) and the changing incentives they face. This suggests at least three unanswered questions: First, what is the impact of firm patent strategies on follow-on public knowledge accumulation? Second, do the social processes of academic communities ameliorate the impact of academic patents in a measurable way? Third, does changing licensing and enforcement have an ameliorating effect and if so, for whom? I initiated three ambitious studies to address these issues.

**Mediating Impact of Firm Strategy.** Firm patent strategies in human genetics have a particularly powerful impact on public knowledge, compounded by the complex landscape of patents that emerges when firms (and universities) patent their ideas in this field. In “Does Patent Strategy Shape the Long-Run Supply of Public Knowledge: Evidence from Human Genetics” (Huang & Murray 2008) we analyze the impact of firm patent strategy on long-run public knowledge accumulation. Within the sample of 1,279 gene patent-paper pairs, we find that private-sector patents have a more significant impact than public-sector owned patents on follow-on public knowledge accumulation. The impact of these patents is increasing in the scope of the patents, in the gene’s link to human disease (particularly cancer) and in the fragmentation of ownership across the patent landscape. These conclusions inform policymakers considering patent reform and fill a gap in our understanding of firm strategy. In particular, while knowledge-based firms seeking competitive advantage often draw on public knowledge to create patented knowledge, prior to our studies, there was a limited understand of the converse relationship – the impact of these patent strategies on public knowledge production.

**Mediating Impact of the Academic Community.** The impact of patent grant on public knowledge accumulation comes in large part from the actual (or expected) enforcement of patent rights. This is not limited to industry ownership. For example, as I described in “The Stem Cell Market: Patents & the Pursuit of Scientific Progress” (Murray 2007) published in *The New England Journal of Medicine*, the University of Wisconsin aggressively enforced its human embryonic stem cell patents on other academics and on industry researchers. It used its control over research materials (that can anyway be restricted without IP rights) and over the patented methods. However, over time it reduced its demands after being pressured by academic scientists. In “Learning to Live with Patents: Assessing the Impact of

Legal Institutional Change on the Life Science Community” (Murray & Stern 2008), we build on examples such as these to argue more generally that researchers respond to constraints imposed by IP in two distinct (but potentially co-existing) ways: acquiescence and adaptation. We tested this notion on our sample of *Nature Biotechnology* patent-paper pairs. We show that these two processes unfold over time and have a shifting impact on follow-on innovation. Moreover, adaptation is more rapid for high-status academics than their low-status counterparts, highlighting the importance of the social organization of science in shaping the response to IP. More broadly, our work initiates further studies of the role of legal institutions in the structure and practices of scientific communities.

**Industry-Academic Interaction:** The DuPont-NIH Memorandum of Understanding in 1999/2000 reducing enforcement of the Oncomouse (and Cre-lox) patents provides the final setting in which I examine the causal impact of these shifts to greater openness as described in “Of Mice and Academics: The Role of Openness in Science” (Murray et al. 2008). This paper deepens our understanding of how increasing openness shapes follow-on innovation, by exploring what types of researchers and research projects are most likely affected by such changes. The main contribution of this work is to move beyond the simple idea that reducing IP changes the incentives to increase follow-on research. Instead, this paper emphasizes that openness is also crucial to the establishment of many diverse new research projects – a feature we measure by capturing follow-on research by new researchers using new key words. Analyzing 2,230 mouse-papers (describing engineered mice) we find strong evidence for these effects, disentangling the impact of IP licensing agreements on scientific communities subject to different rules and norms of openness.

Taken together these three papers provide rich quantitative insights into the ways in which firms and universities use IP to shape follow-on scientific knowledge production, and reciprocally, how the social organization of science shapes the response. More than simply linking patents to public knowledge production, this work examines how particular patent strategies and enforcement contracts contour accumulation. Furthermore, it describes the type of knowledge being accumulated, distinguishing new versus old research lines, new versus existing researchers etc. For those interested in economic growth and innovation, it begins to articulate the dynamics of researchers’ entry and exit into particular research lines. It also helps explain how a complex of economic and social factors shapes the entry of researchers into scientific fields and their subsequent performance. This builds up the micro-foundations of scientific progress because it is through these dynamics that the trajectories of innovative progress are made. It also suggests new research questions for scholars of IP strategy, expanding their focus to include the public commons as well as private property. Specifically this work suggests that the public commons are highly sensitive to patent strategy. Thus, before we conclude that open innovation strategies are a way of getting “something for nothing” we must consider whether they limit the long-run production of the very public goods upon which firms have come to rely.

## **FUTURE DIRECTIONS**

My future research expands my focus in two directions. First, I have started to examine institutions other than IP. I am considering the impact of a broader range of institutional changes on knowledge production in scientific communities in the US and beyond: restrictions on research agendas, access provisions to scientific knowledge, and changes in scientific governance. This research aims to contribute more broadly to our understanding of the organizational and institutional foundations of scientific work. Second, my focus has expanded to explore in detail the strategies firms pursue as they seek to contribute to and benefit from public (common) knowledge production with a wide array of parties. This includes sharing of clinical trial data among firms, exchange of patient tissues, genomes and genealogies between firms and individuals, and materials sharing in fields such as chemistry and nanotechnology. It is a line of research that I expect will contribute to our understanding of organizations and communities operating at the intersection of commercial (particularly legal) and public institutions.

In conclusion, the overarching ambition of my work is to deepen our understanding of scientific progress at the intersection of academic and commercial institutions. In doing so, I plan to reveal the social and economic micro-foundations of scientific progress to the point where they provide clear, predictive insights. This agenda will continue to require a careful balance of in-depth fieldwork and novel empirical methods, combined with a broad understanding of the relevant theoretical debates. The results should deepen our insights into which individuals, firms and nations are able to build cumulative advantage from science, expand our understanding of the social organization of scientific communities and their institutional foundations in the modern economy.

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