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Abstract

In this special issue, we focus on the particular impacts of neoliberalism as a regime of scientific management. Drawing on a wide range of studies from other fields, as well as the four cases in this issue, we argue that while there are important differences in how neoliberalism has been implemented across nations and disciplines, there are a set of key principles and common outcomes that can serve a heuristic function for STS scholars attempting a more careful examination of neoliberalism. These common outcomes include: the rollback of public funding for universities; the separation of research and teaching missions, leading to rising numbers of temporary faculty; the dissolution of the scientific author; the narrowing of research agendas to focus on the needs of commercial actors; an increasing reliance on market take-up to adjudicate intellectual disputes; and the intense fortification of intellectual property in an attempt to commercialize knowledge, impeding the production and dissemination of science. Taken together, these shifts suggest that the impact of neoliberal science policy and management extends far beyond the patent system into the methods, organization, and content of science. We thus urge STS scholars to undertake a detailed exploration of exactly how the external political–economic forces of neoliberalism are transforming technoscience.

Keywords

commercialization, neoliberalism, political economy, privatization

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While the idea that the 20th century was a golden age of science free from outside influence is clearly mythic (Kleinman, 2003; Mirowski and Sent, 2002; Rasmussen, 2002, 2004), it is also clear that the relations between public science and private profit have shifted dramatically over the past 30 years with the broad global movement towards neoliberalism.¹ Neoliberal policies, while varying across national contexts, have shifted methods, organization, and content in similar ways throughout the university. Given both the powerful impacts on the university and the growing attention to neoliberalism across the social sciences, it is surprising that STS scholars have not given more concerted attention to neoliberalism. The existing literature in STS has been notably vague about neoliberalism's definition and temporal and geographical specificities, as well as the extent to which neoliberal political-economic relations beyond academia shape what happens within it. The tendency instead has been to attribute many of the great transformations to actors internal to the university, ranging from the 'performativity' literature on economics (MacKenzie et al., 2007) to the rise of strong intellectual property (IP) (Berman, 2008), and to the accommodation to corporate protocols (Shapin, 2008). Curiously enough, this may have been one legacy of the modern STS field's repudiation of the Mertonian division between internal and external influences on science. While rejecting this division has been enormously productive for building the STS field, we believe it is time to reconsider what it portends for science studies in an age of neoliberal policies.

Thus, for this special issue, we have brought together four case studies that explore the broader territory of relations between private profit and public science. In each case, the authors identify neoliberal-influenced policies and philosophies at work in reshaping the production and consumption of a particular scientific discipline, focusing on the contextually specific ways in which neoliberal practices have been adopted. It thus falls to this introduction to briefly gather together the threads from the individual papers in order to speak to broader themes about commercialization and privatization in science.

In this introduction, we first provide an outlandishly brief history of neoliberalism and introduce its key concepts and the debates that surround it. We then describe the limited treatment of neoliberalism in STS to date, and make the case that such political-economic analysis should become a more prominent part of the STS toolkit. We conclude by introducing the papers in the special issue with particular attention to the lessons that can be drawn from comparison of these four case studies on issues such as the role of the state and the impacts of neoliberalism on the practice, content, and management of science.

Neoliberalism

Neoliberalism can best be understood as the product of an ('inFleckted') historical 'thought collective' (see Plehwe, 2009) constituted through the Mont Pelerin Society, which was founded in 1947. The Society was formed to create a transnational network of neoliberals (academics and professionals) to promote their image of the market as the central agent in human society, and thus shift government focus from public welfare to market creation and protection. Its first President (1948–60) was the Austrian economist Friedrich von Hayek. Consequently, neoliberalism has been associated with

Austrian economics, although there are good reasons to incorporate far more than this (see the essays in Mirowski and Plehwe (2009)). Other early members more recognizable to the STS community were Karl Popper and Michael Polanyi. Through decades of vigorous debate, Society members developed neoliberalism's core principles on issues ranging from public universities to legal frameworks, and their thinking eventually came to dominate a set of influential institutions, from Chicago School Economics to think tanks such as the Heritage Foundation and the Manhattan and George Marshall Institutes (Mirowski, 2008), to international financial institutions such as the World Bank and International Monetary Fund (IMF).

While neoliberalism has varied in its manifestations in different countries and regulatory arenas, the common core has been the promotion of market-based solutions to a broad range of issues. Neoliberalism brings together the classical liberal economic faith in the ability of properly functioning markets to improve social welfare with a new political commitment to expand market relations into traditionally public arenas such as healthcare, education, and environmental management (Harvey 2005; McCarthy and Prudham, 2004; Mirowski and Plehwe, 2009; Peck and Tickell, 2002). As it developed after World War II, neoliberalism diverged from classical political liberalism by renouncing the passive notion of a *laissez-faire* economy in favor of an activist approach to the spread and promotion of 'free markets'.² Contrary to classical liberalism, neoliberals have consistently argued that their political program will only triumph if it becomes reconciled to the fact that the conditions for its success must be *constructed*, and will not come about 'naturally' in the absence of concerted effort. This had direct implications for the neoliberal attitude towards the state, as well as towards political parties and other corporate entities that were the result of deliberate organization, and not simply unexplained 'organic' growths. 'The Market' could not be depended upon to naturally conjure up the conditions for its own continued flourishing. It needed a strong state (divested of its unnecessary social welfare encumbrances) and the backing of international institutions such as the World Bank and the IMF to take its proper place in the neoliberal order.

Chile became the infamous first test case for neoliberal policies in the 1970s under General Pinochet, as national policy was substantially shaped by Chicago School economists, including students of Milton Friedman (President of the Mont Pelerin Society, 1970–2). Neoliberal policies were subsequently rolled out at the state level in a number of countries, including the UK and the US through the rise of Milton Friedman-inspired politicians under Margaret Thatcher and Ronald Reagan. Neoliberalism became the dominant philosophy of the World Bank and IMF, leading to the era of structural adjustment and the global dominance of neoliberal principles. As Margaret Thatcher famously declared, 'There is no alternative', a quote so frequently repeated to assert the dominance of neoliberalism that it is now referred to simply as TINA. While the ongoing global financial crisis has created doubt in some quarters about the rationality of neoliberal policies, neoliberalism remains the dominant organizing rationale for the global economy.

The key to understanding the relevance of neoliberalism for science studies is to appreciate that it is based upon some foundational precepts concerning *knowledge and how it is best organized*. On the organizational front, as part of the shift towards

market-based solutions, national science policies have been (and continue to be) molded to encourage private investment in science and university–industry partnerships, through avenues such as strengthening intellectual property and decreasing public funding. At an even more fundamental level, neoliberalism reifies the primary function of an ideal economy as a ‘marketplace of ideas’. The fundamental role of the market is not, according to neoliberalism, the mere exchange of things, but rather the processing and conveyance of knowledge or information. No human being (and no state) can ever measure up to the ability of the abstract marketplace to convey existing ideas and to summon forth further innovation.³ Hence the novelty of neoliberalism is to alter the ontology of the market, and consequently, to revise the very conception of society. By its very definition, the market processes information in ways that no human mind can encompass or predict. Both of these characteristics of neoliberalism have profound implications for the organization and practice of science.

In the interests of summarizing our immediate concerns with what eventually became the core principles of neoliberalism – the commercialization of science and the university – we here risk oversimplifying its tenets into eight grossly telegraphed propositions:

1. *The Market is an artifact, but it is an ideal processor of information. Every successful economy is a knowledge economy.* It knows more than any individual, and therefore cannot be surpassed as a mechanism of coordination. This is the core neoliberal argument for why socialism must fail.
2. *Neoliberalism starts with a critique of state reason.* The limits of government are related to intrinsic limitations on a state’s power to know, and hence to supervise. These limits are not fixed for all time. Nevertheless, the Market always surpasses the state’s ability to process information.
3. *Politics operates as if it were a market, and thus dictates an economic theory of ‘democracy’.* This explains why the neoliberal movement must seek and consolidate political power by operating from within the state. The ‘night-watchman’ version of the state ends up repudiated. This tenet justifies alliances with the powerful in order to push the neoliberal agenda, and reinforces right-wing suspicions of what they consider ‘radical democracy’, that is, political action outside a market framework. This is combined with an advocacy of the ‘wisdom of crowds’, as long as that wisdom is expressed through market-like frameworks.
4. *Governmental institutions should be predicated on the government of the self.* Freedom is not the realization of any *telos*, but rather the positing of autonomous self-governed individuals, all naturally equipped with a neoclassical version of ‘rationality’ and motives of self-interest. Foucault (2004, 2008) is strongest on the role of these ‘technologies of the self’, which involve an elaborate reassessment in concepts of human freedom and morality.
5. *Corporations can do no wrong, or should not be blamed if they do. Competition always prevails.* This is one of the most pronounced areas of divergence from Classical Liberalism, with its ingrained suspicion of joint stock companies and monopoly. It underwrites a ‘degovernmentalization of the state’ through privatization of education, health, science, and even portions of the military.

6. *The nation-state should be subject to discipline and limitation through international initiatives.* This was initially implemented through neoliberal takeover of the IMF, the World Trade Organization, the World Bank, and other previously classical liberal transnational institutions. It began as advocacy of 'free trade' and floating exchange rates, but rapidly became subordinate to the wider agendas of transnational corporations, to whom it became attached. Neoliberal 'reforms' can therefore be imposed outside of standard political channels by supra-national organizations.
7. *The Market (suitably re-engineered and promoted) can always provide solutions to problems seemingly caused by The Market in the first place.* Monopoly is eventually undone by 'competition'; pollution is abated by the trading of 'emissions permits'; McCarthyism is mitigated by competition between employers (Friedman, 1962: 20). There is no such thing as a 'public good' or 'market failure', but only a series of problems handled by different governance structures, themselves determined by relative transactions costs (Coase, 1960, 1974).
8. *Redefinition of property rights is one of the most effective ways the state exerts neoliberal domination, since once such rights become established, they are treated from then on as 'sacred'.* Neoliberal economics often presents property rights as though their specific formats were relatively unimportant for the operation of 'The Market', but simultaneously they admit that, once created, they are very difficult to reverse. Hence the best way to initiate the privatization program in any area that previously had been subject to communal or other forms of allocation is simply to get the state to institute a new class of property rights.

The last 30 years demonstrate clearly that these principles manifest in contextually specific ways. They are useful, however, as heuristic devices for STS scholars interested in more careful examination of neoliberalism. These principles point towards commonalities across technoscientific contexts, and also to key arenas for analysis of changing patterns in the organization of science and technology under neoliberal regimes, as states enact policies (often with the aid of international institutions) to develop and protect property rights, self-government, privatization, and the prioritization of the market in delivering services.

Neoliberalism and STS: Why we should pay more attention⁴

STS scholars have primarily addressed the impacts of neoliberalism through studies of the commercialization of biomedicine and biotechnology, addressing topics such as the impacts of patenting, the power balance between states and corporations, and the effects of private funding on public science. The authors of these studies tend to polarize into what Mirowski and Van Horn (2005) refer to as Economic Whigs (for example, Baltimore, 2003; Owen-Smith and Powell, 2003; Thursby and Thursby, 2003) – promoting technology transfer and public/private partnerships – and their opponents the Mertonian Tories – sounding the alarm to protect the norms of science, while preaching deliverance through a return to the supposed Mertonian Golden Age (for example, Brown, 2000; Croissant and Restivo, 2001; Krimsky, 2004).

This debate does not address many critical issues raised by the increasing privatization and commercialization of science. The ongoing integration of public science and private profit has not been limited to the biomedical sphere, but has spread out across the natural sciences and into the social sciences as well. Further, the impact on universities and the sciences is more profound than the biomedical debate would suggest, as demonstrated by a small but growing body of literature (Fallis, 2007; Fisher, 2009; Michaels, 2008; Nedeva & Boden, 2006; Foucault, 2008;⁵ Giroux, 2008; Goldman, 2005; Pestre 2003, 2005; Tyfield, 2010). The surge in university patents is indeed important, but as a manifestation of much deeper changes in scientific practice, management, and content as neoliberal concepts have been used to justify major innovations in the structure and organization of science.

The shifting relationship between markets and universities during the 20th century

Some STS scholars argue that because science has always been beholden to its patrons, the character of those patrons is not particularly important; science has ‘always been commercial’, so the rise of neoliberalism is simply a difference in intensity, not in kind. For example, Steven Shapin writes that:

Throughout history, all sorts of universities have ‘served society’ in all sorts of ways, and, while market opportunities are relatively novel, they do not compromise academic freedom in a way that is qualitatively distinct from the religious and political obligations that the ivory tower universities of the past owed to the powers in their societies. (Shapin, 2003: 19)

By contrast, we argue that particular regimes of science management and funding have specific and profound impacts on the character of scientific production.⁶ Science may always have had economic and political dependencies, but the character of those dependencies matters deeply. As Dominique Pestre pointed out, ‘the fact that Galileo successively worked in a university, then for the Republic of Venice, and finally at the court of the Grand Duke of Tuscany is of direct relevance to the kind of knowledge he produced’ (Pestre, 2005: 30; also Biagioli, 2006a).

The US, for example, experienced three quite different regimes of scientific organization during the 20th century. The post-World War II shift to military organization and funding of science was a marked change from the decentralized organization, pedagogical focus, and rejection of public funding that had characterized academic science during the first half of the century. As we will describe in the next section, the shift away from military organization and funding with the rise of neoliberalism created a similarly stark contrast.

Why neoliberalism is different

In the name of national security and nation building, the Cold War science management regime provided a sustained subsidy of academic research via the innovation of overhead

payments on research grants. The state also supported the democratization of education via the GI Bill, provided generous fellowships integrated into grant structures, and insisted on the open distribution of research results (Asner, 2004; Mirowski, 2010). The rise of neoliberal science management regimes since 1980, particularly the insistence on the commercialization and privatization of knowledge, has created substantive shifts in the organization and practice of science. Perhaps the most obvious shift is the rollback of government funding for, and organization of, public research universities. During the Cold War, excelling at science was considered a key element of national security, and thus the military served as the primary manager and patron of public research. But by 1980, private spending on scientific research in the US surpassed Federal funding for the first time in decades. This private funding is not being spent on in-house research and development, however: American corporations have been steadily jettisoning in-house research and development functions over the past three decades, and are investing in targeted research by contract research organizations and by university-based scientists newly starved for funding (Mirowski and Van Horn, 2005; Varma, 2000). Similar trends can be found in other advanced nations.

In the US, public universities also are losing direct subsidies at the state level. As universities have been increasingly re-envisioned as providers of human capital, rather than educational institutions that prepare students for citizenship (Lambert et al., 2007), it has become increasingly difficult to maintain public support for state-subsidized higher education (Apple, 2003, 2006). Individual universities are thus encouraged to solicit more private funds to offset cuts in state subsidy. But the more the university becomes embroiled in market activities, the more it loses any political justification for state support, resulting in a downward spiral of appropriations and the de facto privatization of the American public university system. Before the current global financial crisis, state contributions to budgets of flagship public research universities hovered at about 20 percent, but with the economic contraction, even that paltry contribution has fallen. As a number of analysts have pointed out, this neoliberal re-envisioning of the role of higher education is part of an effort to turn universities into competitive global service industries. Universities are being exhorted to become more like corporations – whose products are ‘information’ and ‘human capital’, and whose customers are students – as a prelude for the state to withdraw from all responsibility for the provision of education.⁷

Another impact of the emphasis on commercialization is the reversal of the Cold War trend of viewing teaching and research as mutually reinforcing activities. If the goal is to produce knowledge that leads to profits, teaching becomes a secondary function. Thus many universities have started replacing tenured faculty with adjunct, often temporary, faculty (as well as with legions of postdocs). As of 2005, more than 48 percent of faculty positions at American colleges that award federal financial aid were part-time and non-tenured, according to the National Center for Education Statistics (Lederman, 2007).

As Sismondo (2009) reveals, commodification of research has also led to the dissolution of the scientific author through the growth of industries devoted to ghost-writing of papers and ghost-management of the research process. Companies hire specialists not only to control data as intellectual property, but also to shape the interpretation of

those data by writing papers and then approaching academics to append their names to the finished product. It is a consequence of neoliberal conceptions of knowledge to buy the 'person' to whom the research will be attributed, as well as buying the research itself.

A last widely noted impact of the neoliberal science management regime is the aggressive promotion and protection of intellectual property in hopes of gaining commercial value from knowledge. There is an intimate connection between the neoliberal recasting of the market as an information processor, and the growth of the conviction that knowledge should be commodified. This connection seems all the stronger when one considers that, as several recent studies have pointed out, for the vast majority of universities patenting has been a losing financial proposition (Geiger & Sa, 2008; Greenberg, 2007; Newfield, 2008: ch. 12; Powell et al., 2007). Insisting upon the commercialization of knowledge has, so far at least, proven more ideologically effective than economically practical.

While STS scholars tend to focus on patents and point to the 1980 Bayh-Dole Act as the watershed moment, it is important to note that neoliberal intellectual property protection is more complicated. Bayh-Dole was only one bill in a sequence of legislation throughout the 1980s that expanded the reach of intellectual property in the US and internationally (Berman, 2008; Slaughter & Rhoades, 2002: 86). Vastly expanding the scope of this American legislation, representatives of corporations in high-tech industries formed the International Intellectual Property Alliance in 1984 to insert issues of intellectual property into larger trade negotiations (Drahos and Braithwaite, 2002; Sell, 2003). They were wildly successful in doing so, using the Uruguay Round of negotiations over the General Agreement on Tariffs and Trade to impose US standards and levels of intellectual property protection on developed and developing countries alike, and to enforce them with trade sanctions through the World Trade Organization. Over the same period, corporations sought and won numerous amendments to strengthen both patent and copyright, and in 1982 they managed to have a special Court of Appeals in the Federal Circuit dedicated to patent cases.⁸ The scope of what is deemed susceptible to patenting in America has been progressively broadened, and challenges to the legitimacy of patents have become less successful. It is now possible to patent anything from living beings, to computer code, to business practices; the patent system has come dangerously close to allowing the patenting of ideas themselves, *particularly when those ideas arise in scientific research*.⁹ The very notion of a public sphere of codified knowledge has been rolled back at every point along its perimeter.

Patents are not the only, or even the most important component, of the rapidly expanding protection of intellectual property. Even with loosened patenting standards, it would still be far too unwieldy and time-consuming to patent every single research tool. Material transfer agreements (MTAs) have thus become the instrument of choice to control the commercial implications of cutting-edge research. MTAs affect scientific practice through confidentiality clauses and various permutations of prior restraint upon publication or other disclosure of findings, which retards their presentation and publication, as Evans (2010) demonstrates in his paper in this special issue. But the deeper effects of MTAs come from the so-called 'reach-through clauses' that lay

claims upon any IP that might arise in future research by the recipient of the research tool. These clauses lately have come to include options for licenses on future research materials, grant-backs for newly discovered uses for the existing material, splitting of future royalties (or costs), royalty-free access to the organization's patent portfolio, broad claims over 'derivative' materials (such as offspring of organisms, related cell lines, collateral secretions), patent prosecution controls, indemnification against any liabilities that might arise from use of the research material, and time limits on the use of the material (Mirowski, 2010).

Unwillingness to sign such overreaching clauses has slowed, and sometimes blocked, both individual research projects and knowledge transfer among scientists. Surveys of scientists published both in mainstream science journals and in specialist biomedical journals argue that MTAs are an increasingly common roadblock in the practice of science.¹⁰ Henry et al. (2003: 446) report in a survey of 46 research organizations that all of their respondents used MTAs to protect unpatented information and material, and that almost 75 percent of them reported having at least one MTA negotiation breakdown within the past year. In one survey in Belgium, 60 percent of researchers reported abandoning projects because of problems with intellectual property restrictions on research tools (Rodriguez et al., 2007). As the university becomes more commercialized, the circle of research tools encumbered by MTAs has continued to widen, and so have the impacts on scientific practice.

We have argued here that neoliberal science policy is creating a regime of science organization quite distinct from the Cold War science management regime. While there are important differences in how neoliberal ideology has been implemented across nations and disciplines, there are some telling similarities: the rollback of public funding for universities; the separation of research and teaching missions, leading to rising numbers of temporary faculty; the dissolution of the scientific author; and the intense fortification of intellectual property in an attempt to commercialize knowledge, impeding the production and dissemination of science. We turn now to the ways in which these broad trends manifest in the particular cases in this issue.

The case studies in this special issue

Neoliberalism has had a broad range of impacts on scientific practice and organization, and the papers in this issue thus examine a variety of phenomena, investigating the impacts of public/private partnerships on scientific publication practices (Evans, 2010), the privatization of an existing science to enable a new market in ecosystem services in the US (Lave et al., 2010), the commercialization and privatization of legal science in Britain (Lawless and Williams, 2010), and the contextual specificity of the embrace of neoliberal ideas by private sector science in the US and Britain (Randalls, 2010). Despite this diversity, there are notable patterns across the papers.

First, the breadth of the scientific fields covered in these cases clearly demonstrates that neoliberalism's effects are being felt beyond biomedicine. Environmental sciences ranging from stream restoration (Lave et al., 2010), to plant biology (Evans, 2010), to meteorology (Randalls, 2010), and to the field of forensics (Lawless and Williams, 2010), are covered in this issue. It is worth noting that in response to the

call for papers for this issue we received dozens of abstracts dealing with neoliberal impacts on everything from fisheries science, to materials science, and to sociology.

Second, while there is no singular storyline here, either on how neoliberal policies have been implemented or the extent to which particular fields have acquiesced to (or embraced) them, the papers in this issue demonstrate some common impacts. In each case, science is increasingly produced in direct response to corporate requirements, as scientists attempt to create forms of research that will enable new environmental and legal markets to function. Unsurprisingly, this increasing commercialization creates a tension featured in all the papers, but most especially in the case Lawless and Williams examine: the need to meet market imperatives while still allowing the products of science to be seen as value-free. The attempt to preserve the external sanctity of 'Science' whilst encouraging the internal proliferation of commercialization ties scientists and administrators in rhetorical and practical knots.¹¹

It is also noteworthy that in all the disciplines addressed in these papers, what is accepted as good data has become highly contested, leading to shifts not only in the applications, but also in the basic core of these scientific fields. In three of the case studies in this issue (Lave et al., 2010; Lawless and Williams, 2010; Randalls, 2010) these contests are adjudicated not through the traditional mechanisms of science, but simply by what is taken up (or not) by the market. One notable consequence of this appears to be a narrowing of focus. For example, in stream mitigation banking, which Lave et al. (2010) discuss, broader concerns about stream ecology and water chemistry are sidelined in restoration projects in favor of a more pointed focus on variables far easier to both engineer and measure.

Third, there are some common actors promoting shifts in practice characteristic of neoliberal science regimes. Most notably, the state has been the major protagonist in promoting market-based solutions.¹² Evans' paper demonstrates some of the impacts of long-standing state attempts to neoliberalize universities and research laboratories by encouraging private funding for public researchers. Lave et al.'s paper highlights the ways in which government regulation enables a market in stream restoration, whilst both Lawless and Williams, and Randalls, show the UK government not simply enabling, but actively promoting the commercialization of forensic science and the privatization of meteorological science and service provision. Clearly, commercialization is not an independent trend to which government regulation merely reacts. Instead, states are key players in the expansion of neoliberal policies into scientific practice and management. Once commercialized, science becomes more easily privatized through expanded property rights, corporate (and university) secrecy and ownership of ideas, and the development of a competitive rather than collaborative enterprise of science.

Finally, as best demonstrated by Evans, the direct effects of commercial imperatives on scientific research are not necessarily obvious. It is only by looking beyond what appear as rational, neutral claims about the proper role of science and its increasingly commercialized organization that we can understand the influence of neoliberal philosophies. STS scholarship is ideally suited for revealing the continuous, diverse, and sometimes subtle ways in which neoliberal stances are being promulgated and cultivated in diverse fields of study.

Conclusion

Based on existing studies of neoliberalism and its effects, and the cases in this special issue, we have argued that the impacts of neoliberal policies on the conduct, products, and organization of science have not been trivial. First, the character of the university is changing as new privatized regimes of science management shift the sources and quantities of funding, the organization of research and teaching, and the intellectual and commercial status of knowledge claims.

Second, the strengthening of intellectual property protections and the linked insistence on the commercialization of knowledge are transforming the production and dissemination of knowledge. Evans, in this issue, points to a drop in publications by researchers engaged in public/private partnerships, and surveys cited above report that research projects have been frustrated and even stopped entirely by disputes over MTAs. The focus upon patents only serves to divert attention from where the real obstacles have been erected. The cases also demonstrate that science is increasingly being produced for particular markets, with a resulting contraction in the focus of research. This narrowing is only compounded when market uptake becomes a tool for adjudicating scientific disputes, as is reported in three of the papers in this issue. Further, contestations of what constitutes good evidence in power struggles over the creation of new markets call into question the validity not just of the scientific applications under dispute, but also of the basic core of fields. Thus it seems possible that instead of producing widely touted innovations for clients, neoliberal science regimes may leave us with the production of ignorance.

Finally, the impacts of neoliberal science policies include disturbingly elitist patterns that STS scholars are uniquely positioned to expose. For example, Leigh Johnson's work on the privatization of hurricane forecasting highlights the growing split in access to the products of privatized science. Through a spin-off business, university-based researchers have developed forecasts for a major energy company that predict the path of hurricanes 7 days in advance, with an accuracy of 100 miles (160 km); by contrast, the US National Hurricane Center's forecasts can achieve the same track accuracy only 48 hours in advance (Johnson, 2009). Consider what the Federal Emergency Management Agency (FEMA) and the State of Louisiana might have been able to do had they been able to access accurate forecasts of the path of Hurricanes Katrina and Rita a week in advance; at present, the only entity with access to such knowledge is a major energy company. Equally, consider the potential social justice issues that could arise if geoengineering became dependable enough for major insurers and other corporations to deflect hurricanes into less economically damaging pathways (Block, 2006). Jill Fisher's (2009) work shows a similarly disturbing trend in access to medical treatment, as clinical trials increasingly use the bodies of the poor and uninsured to test drugs they will not have access to if approved.

Neoliberalism continues to have profound impacts on the organization, practice, and social implications of science. We thus suggest that STS scholars undertake a detailed exploration of exactly how neoliberal theories of society are transforming technoscience. Such an exploration will require not just the more familiar elements of the STS toolkit, but also analysis of external political-economic forces: to understand

the neoliberal regime of science organization and management, we must understand where it's coming from.

Acknowledgments

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Notes

1. For various approaches to this phenomenon, see Mirowski and Van Horn (2005), Ciafone (2005), Davies et al. (2006), Robertson (2006), Canaan and Shumar (2008), Fisher (2009), and Sismondo (2009).
2. The history of neoliberalism is a burgeoning topic in its own right, and would require a separate survey. The interested reader might consult Hartwell (1995), Foucault (2008), Mirowski & Plehwe (2009), Harvey (2005), and Plehwe and Walpen (2005).
3. This doctrine is itself relatively recent, dating at its earliest from the 1930s. It is eminently a *political* and not simply a cultural phenomenon, because it was developed as part of a concerted effort to counteract the rise of planning and other market-skeptical movements that grew out of the Great Depression and the experience of World War II.
4. This section draws heavily from Mirowski (2010).
5. Although Foucault's lectures date from the late 1970s, they have only recently been translated into English, which has magnified their impact on the literature on neoliberalism.
6. We draw the concept of 'regimes' of science organization, funding, and thought styles literature from authors including Coriat and Orsi (2002), Coriat and Dosi (1998), Coriat (2002), Coriat et al., (2003), Asner (2006), Tyfield (2006), Nedeva and Boden (2006), Johnson (2004), and Pestre (2003, 2004, 2005, 2007).
7. Some of the best studies have been Slaughter and Rhoades (2004), Apple (2005), Kirp (2003), Marginson (2007), Frank and Gabler (2006), and Douglass (2008).
8. A number of STS scholars have explored the history of the patent system (Biagioli, 2006b; Biagioli and Galison, 2002; Cooper, 2008; McSherry, 2001; Metlay, 2006; Sherman, 1996).
9. In June 2006 the Supreme Court rendered a decision in the case *Laboratory Corporation of America Holdings v. Metabolite Laboratories, Inc.* (126 S. Ct. 2921, 2926 (2006) (Breyer, J., dissenting)) 'which allowed this patent on a biological fact to remain in effect' (Andrews et al., 2006: 1395). In this case, researchers at Columbia University had found that a high level of homocysteine (an amino acid) is correlated with a vitamin deficiency. The investigators formed a startup firm, Metabolite Labs, and filed for a patent to capitalize on their discovery and a test for homocysteine. With startling hubris, the patent application asserted that the petitioners should be allowed to patent the basic physiological fact, so that they could claim a royalty whenever *any* test for homocysteine was sold (despite the fact that tests for homocysteine were already available, and used to diagnose several medical disorders). When a private corporation, the Laboratory Corporation of America (LabCorp), which had licensed the right

to the test from Metabolite, published a scientific paper suggesting that high homocysteine levels might indicate a deficiency to be treated by a vitamin regimen, Metabolite sued for breach of contract and patent infringement. The US Court of Appeals for the Federal Circuit astoundingly ruled that publishing the fact infringed the patent, and further ruled that doctors would infringe the patent merely by contemplating the physiological relationship. The Supreme Court originally allowed a review of the case, but then dismissed it on essentially technical grounds, so the lower court ruling still stands.

10. See for example mainstream science articles such as Cohen (1995), Abbott (2000), Marshall (1997), and Cyranoski (2002), and discipline-specific papers such as Cuiker (2006), Rounsley (2003), Streitz and Bennett (2003), Campbell et al. (2002), and Vogeli et al. (2007).
11. There are interesting parallels here with debates over military science. See Mukerji (1989) and Eyal (2010).
12. This is consistent with Harvey's observation that under neoliberalism, the state becomes the primary agent of neoliberal reform (2005: 162).

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