Is the Government Buying Science or Support?
A Framework Analysis of Federal Funding-induced Biases

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April 30, 2015

CATO WORKING PAPER
No. 29

CATO
INSTITUTE

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Framework Study for the Cato Center for the Study of Science

By David E. Wojick and Patrick J. Michaels[1]

Executive Summary

The purpose of this report is to provide a framework for doing research on the problem of bias in science, especially bias induced by Federal funding of research. In recent years the issue of bias in science has come under increasing scrutiny, including within the scientific community. Much of this scrutiny is focused on the potential for bias induced by the commercial funding of research. However, relatively little attention has been given to the potential role of Federal funding in fostering bias. The research question is clear: does biased funding skew research in a preferred direction, one that supports an agency mission, policy or paradigm?

Federal agencies spend many billion dollars a year on scientific research. Most of this is directly tied to the funding agency mission and existing policies. The issue is whether these financial ties lead to bias in favor of the existing policies, as well as to promoting new policies. Is the government buying science or support?

Our working definition of "funding-induced bias" is any scientific activity where the prospect of funding influences the result in a way that benefits the funder.

While the basic concept of funding-induced bias is simple, the potential forms that this bias might take are far from simple. Science is a complex social system and funding is a major driver. In order to facilitate research into Federal funding and bias it is necessary to isolate specific kinds of bias. Thus the framework presented here is a taxonomy of funding-induced bias.

For the purposes of future research the concept of funding-induced bias is analyzed in the following ways:

1) the practices in science where bias can occur,
2) how agency policy can create bias,
3) the level at which bias is fostered, and
4) indicators of bias.

Fifteen different scientific practices are analyzed, ranging from the budgeting and

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funding for research to the publishing and communication of results. For each of the fifteen practices there is a snapshot of the existing research literature on bias, plus a brief discussion of the directions that new research might take in looking into funding-induced bias. The potential for quantifying the extent of bias is also addressed.

In order to provide examples along the way there is a special focus on climate change. Federal policies on climate change and federal funding of climate research are both extensive. The linkage between these policies and research has become a major topic of discussion, including numerous allegations of bias.

The research framework provided here applies to the study of all funding-induced bias in science, not just to climate change science. The linkages between Federal policy and federally funded science are extensive and not well understood. Moreover, these linkages have policy implications, especially if they are inducing bias in scientific research. However, policy is not our topic here. Rather we are addressing the needed research that might lead to new policies.

Conclusions and Observations

What we have found, as explained in this report, is that some types of bias are being studied extensively and quantitatively. Various aspects of peer review and publication bias, especially in biomedicine, appear to be the most heavily researched types of bias. The role of funding in inducing bias is frequently alluded to as a potential financial conflict of interest. But it is not the focus of most research, which tends to look more at the practice of bias than at its cause. A new research thrust is likely needed.

Bias Induced by Public versus Private Funding

The concept of funding induced bias is one that specifically occurs in some of the fifteen bias research types that we have identified, but not in all of them. It tends to occur where specific funding is the issue. Here we are using the concept more broadly, to include cases where the funding may be somewhat distant from the activity in question, such as in the communication of research results.

Our focus on bias induced by Federal funding is not meant to suggest that commercially induced bias is less important. Our point is simply that while commercially induced bias is already a significant research area, the investigation of potential federally induced bias is not an active research area. There appears to be a major gap in bias research.

This asymmetry in bias research may be due to the fact that the commercial funding of research is very large in biomedicine, where incorrect science can literally be life threatening. Much of the present bias research is in the medical area. On the other hand federal funding of health research is also very large. The National Institutes of Health get about half of the entire Federal budget for basic research.

Whatever the reason for the present bias research focus on commercial funding, the fact

remains that the Federal Government funds a lot of research, most of it directly related to agency missions, programs and paradigms. In some areas, especially regulatory science, Federal funding is by far the dominant source. Clearly the potential for funding-induced bias exists in these cases.

It should be noted that we make no specific allegations of Federal funding induced bias. We do, however, point to allegations made by others, in order to provide examples. Our goal here is simply to provide a conceptual framework for future research into scientific biases that may be induced by Federal funding.

The role of government funding in inducing policy driven bias seems to have received very little attention, even though it may be widespread. There are certain exceptions, most noticeably in the climate change debate and environmental policy in general. But here the attention is more a matter of public concern than one of quantitative scientific research.

Cascading Amplification of Funding-induced Bias

In this report we are mostly concerned with individual types of funding induced bias. But there is an intrinsic sequence to the various biases we have identified and this raises the possibility of cascading amplification. By amplification we mean one biased activity is followed by another, such that the first bias is increased.

A simple, and perhaps common, example of amplification might be when the hype in a press release is exaggerated in a news story. Let's say the press release overstates the importance of the research result, but with some qualification. The news story then reports the result as a great breakthrough, far more strongly than the press release, ignoring the latter's qualifications. In this way the original bias has been amplified.

Cascading amplification when one biased activity is followed by multiple instances of amplification. Using our example, suppose a single biased press release generates many different news stories, which vie with one another for exaggeration. This one-to-many amplification is properly termed a cascade.

Moreover, there is the possibility of cascading amplification on a very large scale and over multiple biased stages. Here is an example of how it might work.

1) An agency receives biased funding for research from Congress.

2) They issue multiple biased Requests for Proposals (RFPs), and

3) multiple biased projects are selected for each RFP.

4) Many projects produce multiple biased articles, press releases, etc,

5) many of these articles and releases generate multiple biased news stories, and

6) the resulting amplified bias is communicated to the public on a large scale.

One can see how in this instance a single funding activity, the agency budget, might eventually lead to hundreds or thousands of hyperbolic news stories. This would be a very large scale cascading amplification of funding-induced bias.

Climate Change Examples

In the climate change debate there have been allegations of bias at each of the stages described above. Taken together this suggests the possibility that just such a large scale amplifying cascade has occurred or is occurring. Systematic research is needed to determine if this is actually the case.

The notion of cascading systemic bias, induced by government funding, does not appear to have been studied much. This may be a big gap in research on science. Moreover, if this sort of bias is indeed widespread then there are serious implications for new policies, both at the Federal level and within the scientific community itself.

Is the Government Buying Science or Support?

A Framework Analysis of Funding-induced Biases in Science

I. Introduction

Thomas Kuhn (1962) pointed out in his groundbreaking work "The Structure of Scientific Revolutions" that fundamental beliefs can take over a scientific field. He called these entrenched beliefs "paradigms" and noted that they tend to direct scientific thinking in specific directions. Once these beliefs become entrenched they are difficult to dislodge, despite growing evidence that they may be incorrect. Science, like any human endeavor, is subject to fads and fashions.

Clearly processes like paradigms and fashions can influence the funding of research, especially government funding. Kuhn notes that paradigms tend to specify not only what the important questions are, but also what the answers are expected to look like, and these questions and answers are the focus of research funding. At some point this influence can become bias, especially when the paradigm becomes questionable. This may be especially true when the outdated paradigm is built into the mission or policies of a research funding government agency.

Biased funding in turn biases the funded research in complex and subtle ways. The purpose of this project is to systematically analyze many of these forms of funding-induced bias in science, in most cases including examples from climate science. **It should be noted however that this sort of bias need not be dishonest, and often is not, even though funding is involved.** As Kuhn points out, defending a paradigm is the norm in scientific activity. Many of the biases are ideological in nature. Funding is part of the ideology, often a central part.

II. Scope and Direction of this Paper

This paper "unpacks" each of over a dozen types of potential funding-induced biases, in several ways. First is a brief analysis of the concept itself. Second there is the Literature Snapshot, the result of a simple literature search to determine and report on the extent to which each type of potential bias appears to be the object of scholarly research. We also include suggestions for new research directions, in particular the quantification of the bias in question. In most cases we also provide one or more examples where bias has been alleged, in each case drawing on the climate change debate.

III. Literature Snapshots

The Literature Snapshots are based on a method Wojick and his colleagues developed for the Office of Science at the US Department of Energy. It uses Google Scholar, which is free to all and includes some very useful functionality. The reader can easily replicate or expand upon our searches.

To begin with we find one or more search words or phrases that go to the heart of the bias type in question. Two types of searches then help to quantify the scale of the recent research being done on this type of bias. The first finds all those reports that use the search term in their title, published in the last five years. When a term is used in the title it is very likely that this topic is the focus of the reported research. Unlike the general Google search engine, the Google Scholar search engine finds relatively little extraneous material, so the number of hits returned is a good indicator of the size of the research effort.

We also do a full text search to find all the recent documents that use the search term at all. This number is of course usually much larger than for those documents that use the term in their title, and it may include a good number of extraneous hits, but it is still a useful indicator of the popularity of the concept.

Returning to those documents that use the search term in their title, we can think of them as centered on the research we are interested in. There are, however, a lot of closely related research reports that do not happen to use the search term in their title. Google Scholar offers two different ways to find these reports as well. These two functions each depend on picking one of the reports from the term-in-the-title hit list. Given such a choice one can then initiate the "related articles" function or the "cited by" function.

Google Scholar tends to present highly cited articles at the top of the hit list. These tend to be dated early in the selection period, because it takes time to accumulate citations. Heavily cited articles are often quite influential so looking at all the articles that cite a highly cited article, via the "cited by" function, can be instructive as far as how the research has developed.

The "related articles" function uses a powerful semantic algorithm to compare the full text of every article in the entire Google Scholar database. It finds the hundred or so most closely related articles for the article originally selected, based on all the language used in each article. This is very useful because it does not depend on specific search terms.

Beginning with the title search, then working a little with "cited by" and "related articles" one can quickly get a feel for the research area in question. This is what we have done in developing the Literature Snapshots. Note that these are not full-scale literature searches; they are simple snapshots of what the research area seems to be about in general.

IV. Research Directions

Issues for bias research:

A. <u>Source of the bias</u>: What is the "agency mission" aspect of funding-induced bias?

Funding-induced bias is likely to flow from a specific aspect of the agency's mission. For bias research purposes it may be important to know what that mission aspect is. That is, what role does the bias play with respect to the agency mission? There are a number of different roles that bias may play and several are described briefly below.

1) Protecting a policy. Funding is often directed to research that is related to an existing policy. Here the bias issues are likely to be related to whether the research that gets funded is objective as far as the merits of the existing policy are concerned. In particular there is the danger that the research will assume the policy, rather than evaluating it.

2) Growing the mission with a new thrust. Sometimes research is funded to develop a new mission thrust, such as identifying a new problem that falls under the agency's mission. Here the danger is that the research will assume the new thrust is justified, rather than evaluating it.

3) Preserving the existing scientific paradigm. Agency policies, programs and practices are often based on past science, which operated under a specific paradigm. When this paradigm begins to be questioned within the scientific community, there is the danger that the agency will simply continue to fund research under the existing paradigm. In effect the agency is taking a side in a scientific controversy, rather than working to resolve that controversy.

B. <u>Scope of the source</u>: What level of government is most directly related to the bias-inducing mission?

The US Government is organized hierarchically by mission, with lower levels having narrower and more specific missions. As a result, Federal funding of research may be related to agency mission at several different levels. It is often the case that a given research activity or area is most directly related to a specific mission level and this may be useful to know in terms of understanding the role of the bias in supporting the mission.

In order to illustrate this concept of the mission level of research, we briefly describe a series of levels below, using climate-related research funded by DOE as our example. Similar analyses could be done for most federally funded research, because funding is usually mission-oriented. The typical chain of command is federal, agency, office, program and project, with each level containing several (or many) instances of the next lower level.

1) Federal or multi-agency level. As an example, there is an area of funded research into what is called the social cost of carbon or SCC. The results of SCC research are used by many Federal agencies, so the mission scope of this research is basically Federal.

2) Agency or multi-office level. In the Department of Energy, research into the feasibility of future low carbon emitting energy systems is used to make mission-related decisions involving many different DOE offices. The mission scope is thus departmental.

3) Office or multi-program level. DOE's Office of Energy Efficiency and Renewable Energy (EERE) conducts research that is related to multiple renewable energy technology programs, for example energy storage research. The mission scope in these cases is multi-program, even if energy storage is itself a research program.

4) Program or multi-project level. A research program targets a specific research area in an open ended way. For example DOE's EERE has a large solar energy research program.[1] Some of this research is related to the program as a whole, such as studies of geographic solar energy potential. This is program level research.

5) Project level. A project is a research activity with a specific goal and end date.

Most federally funded research is probably focused at the project level, but given the hierarchical mission structure that research may have implications at higher mission levels. This means that determining the mission levels most directly related to specific bias activities may not be simple.

C. <u>Indicators of possible bias</u>: controversy and allegations.

Bias does not go unnoticed, so controversy over specific aspects of the science related to a Federal mission may be evidence of funding-induced bias. Controversy may include one or more of the following general aspects of the science:.

a) hypotheses being assumed or defended,

b) methods used in funded research,

c) assertions of what are claimed to be established facts, and.

d. the use of specific models and assumptions in research.

The strongest evidence of bias may be specific allegations, along the lines of the fifteen practices of bias described at length below.

D. Approaches to the research: test the practices in question for bias, preferably using quantitative methods.

The combination of specific sources and levels of bias, with aspects of controversy and allegations of biased practices yields a large number of specific possible cases that can be investigated individually. There are in fact several hundred different combinations of the bias related factors described herein. Thus the first step in research will often be to determine the specific case or cases in question. The goal is to be precise as to the possible source, scope, science and type of bias involved.

For example, the specific case may indicate which documents need to be analyzed for evidence of funding-induced bias. In particular, the mission aspect and level are a good starting point for bias research, because bias that is not related to agency mission is unlikely to be funding-induced.

However, some of our fifteen bias practices are not directly funded by agencies. Rather the funding inducement is indirect, rendered by the community as it were. For example, publication in subscription journals is not agency funded but it is an important indirect component of competing for agency funding.

Regarding how US agency missions may be related to the research they fund, it should be noted that the National Science Foundation is a special case, because research per se is NSF's mission. Thus NSF is perhaps more likely to suffer the bias of paradigm protection and less likely to engage in policy support than other agencies. However, NSF is probably also well aware of the policy implications of the research it funds, so this issue is rather speculative. Which agencies induce which biases is after all a scientific question.

V. Assessing the Potential for Quantification of each Type of Bias

The analysis below of each of the fifteen practices of bias includes a brief assessment of the potential for quantification. This assessment includes suggesting feasible approaches to successful quantification for each practice. This quantification assessment typically includes the following issues.

A. Data issues

Is there enough data to support quantification? For example, peer review and selection of proposals and journal articles tend to be black boxes, with little available data. Citations and co-authorship might be viable proxies for peer review. Persistence might be a proxy for selection.

How best to sample the available data? Computer based sampling methods, if feasible, are preferable to manual methods, because the latter are relatively expensive. Randomized sampling methods are preferable to convenience samples but are not always possible. Likewise, is the available data complete or partial? Partial data is often self-

sampled, which limits the scope of the resulting conclusions. Is a lot of processing of the data involved, before it can be analyzed? If so then how should it be done?

B. Quantification Analysis Method Issues

What is the suggested best method of quantification? In particular, is it subjective or objective, that is, is human judgment and classification of the data involved, or just simple counting of clearly defined instances. In the latter case the analysis might be done by computer, which is typically cheaper than manual analysis, depending on the amount of programming involved.

Are indirect methods required? Where direct data is not available, using proxy data may be feasible, but this involves linking the proxy to the bias in question. Semantic approaches may also be feasible. For example, in the case of the hyping of research results in press releases, an approach to quantification might be by counting the occurrence of "hype" words in a sample of press releases but not in the related abstracts or articles.

VI. Potential Bias in US Climate Research

One special focus here is the climate change debate, especially as modulated by the US Global Change Research Program (USGCRP). Note that the USGCRP is not a program in the sense of an agency program, as described above. Founded in 1990, the USGCRP is an inter-agency coordination effort that includes most of the climate science research programs run by thirteen different federal agencies. The USGCRP is presently funded at over two billion dollars a year and accounts for a significant fraction of climate research worldwide.

Today the paradigm of human-caused (or anthropogenic) dangerous warming is being seriously questioned, but the USGCRP still maintains the old paradigm, as evidenced in their remarkably alarmist National Climate Assessment reports titled "Global Climate Change Impacts in the United States," that are produced every four or five years.[2] (Systematic problems with these reports have been extensively documented and entered into the public record by Cato scholars Parickt Michaels and Chip Knappenberger).[3]

In the context of the climate change debate there have been numerous allegations of funding-induced bias. Therefore, in order to illustrate each of our fifteen listed practices of bias, we are including as an example one or more cases where such allegations have been made in the US climate debate.

VII. Potential Practices of Funding-Induced Bias

In this section we briefly describe fifteen specific practices of bias in the context of funded scientific research. For convenience, as well as introductory discussion, these fifteen are first listed below as a kind of table of contents for this section:

1. Funding agency programs that have a biased focus.

2. Agency Strategic Plans, RFPs, etc., with an agenda, not asking the right questions.

3. Biased peer review of research proposals.

4. Biased selection of research proposals by the agency program.

5. Preference for modeling using biased assumptions.

6. Biased peer review of journal articles and conference presentations.

7. Biased meta-analysis of the scientific literature.

8. Failure to report negative results.

9. Manipulation of data to bias results.

10. Refusing to share data with potential critics.

11. Asserting conjectures as facts.

12. False confidence in tentative findings.

13. Exaggeration of the importance of findings by researchers and agencies.

14. Amplification of exaggeration by the press.

15. More funding with an agenda, building on the above, so the cycle repeats and builds.

While each of the biased practices listed above may occur in isolation, there is also a potential sequence to them, or a cascade. Science is a complex social system and funding is a major driver. Some of the practices listed above do not involve direct Federal funding, but each can clearly be influenced by the existence or mere prospect of such funding.

Each of these fifteen specific biased practices is discussed briefly below. Taken together they provide a kind of "field guide" to funding-induced bias.

1. <u>Funding agency programs that have a biased focus</u>.

Concept Analysis

In some cases Congress funds research programs that may be biased in their very structure. For example, by ignoring certain scientific questions that are claimed to be important, or by supporting specific hypotheses, especially those favorable to the agency's mission or policies.

Literature Snapshot

There appears to be relatively little research into this kind of bias. Google Scholar lists just 44 articles during 2010-2014 that have "federal funding" plus "research" in their titles. With the possible exception of the stem cell issue, none of these articles look to be about funding-induced bias, and the stem cell issue is more of a policy issue than a scientific one. Most of the articles discuss the impact of federal funded research.

Expanding the Google Scholar search to full text generates over 20,000 hits, but again most of the articles relate to federal funding per se, not to potential biases induced by this funding. There are some exceptions, however, mostly where it is alleged that important aspects of the research agenda are under funded. An example is JS Benner et al.[4]

Research Directions and Prospects for Quantification

Agency funding requests and final research budgets are public documents, which are readily available for analysis. At the Congressional level there are two stages in agency funding -- authorization and appropriation. Each of these steps may be accompanied by lengthy public reports. In many cases both the request and the funding occurs at the program level.

Therefore, one basic approach to looking for bias is to examine how the funds are allocated to various research programs and questions. For example, suppose there are two competing hypotheses, one of which favors an agency mission or policy, while the other does not. Heavy funding of the former, compared to the latter, might be evidence of bias.

In the climate debate an example of this sort of bias might be the heavy funding of carbon cycle research compared to sun-climate research in the USGCRP budget. The government's policy on climate change is based on the hypothesis that carbon dioxide emissions are the principal driver. That climate change is driven by solar activity is a competing hypothesis.

Given that this bias might be measured in dollars there is an excellent prospect for quantification. However, the budget documents might not break the dollars out into the funding categories needed to do the bias analysis, which presents a data problem. The use of proxies or estimation techniques may be necessary in such cases. Relatively subjective interpretation may also be required.

Climate Debate Example(s)

Example: controversy over the scope and direction of the multi-billion dollar US Global Change Research Program (USGCRP) budget. A Google search on the terms "climate change funding bias" (without quotation marks) gives the flavor of the debate. In their FY 2015 budget document, "Our Changing Planet,"[5] page 30 of the FY 2015 budget report says "These investments in global change research will support implementation of the actions laid out in the President's Climate Action Plan,"[6] indicating that the research will support the policy, rather than being scientifically independent.

However, the FY 2015 version provides virtually no information on the research topics or components of the budget. The only breakout is by agency, making analysis difficult. Earlier versions did provide breakouts, so that one could analyze the expenditures for possible bias. For example, the FY 2010 version includes detailed breakdowns of the budget by research topics.[7] These indicate that the topics of the carbon cycle, water cycle, atmospheric composition and adverse impacts dominate the program. These topics are central to the paradigm and Federal policy based on assumed anthropogenic global warming. This apparent bias in funding appears to be policy-driven.

An additional complexity is that the USGCRP actually consists of the climate research related activities of thirteen separate Federal agencies. These activities are funded separately out of each agency's budget, so *Our Changing Planet* is merely a summary document. Detailed analysis for possible bias may have to be done at the agency level.

2. <u>Agency Strategic Plans, RFPs, etc., with an agenda, not asking the right questions</u>.

Concept Analysis

Research proposals may be shaped by agency Strategic Plans and Requests for Proposals (RFP's), also called Funding Opportunity Announcements (FOA's). These documents often specify those scientific questions that the agency deems important, hence worthy of funding. Thus the resulting research proposals may be biased, speaking to what the agency claims is important rather than what the researcher thinks.

Literature Snapshot

There appears to be very little research on this type of bias. A search on Google Scholar for the occurrence of the three terms "Federal" and "research" and "bias" in article titles for the period 2010-2014 gives zero hits! Full text search for these three common words returns over 62,000 items but only a few are even looking at bias, such as gender bias. The occurrence of all three words somewhere in an article is probably mostly just a coincidental combination.

Search for "research" and "bias" in titles gives 371 hits, but only a few of the articles are even related to federal funding. Most are looking at statistical analysis issues, such as sample selection.

There is a small, but interesting, research topic called the "funding effect." Full text Google Scholar search for 2010-2014 gives just 211 hits, of which just 5 find this term in the title. Expanding the period to 2002-2014 gives 329 full text hits and 8 in the title. It appears that the term "funding effect" was coined by Sheldon Krimsky around 2005 and most of the title occurrences are in papers by him. Thus there may be increasing attention to this concept but the literature is still very small. Moreover, most of the focus is on the biasing effect of commercial funding, such as by drug companies. For a Krimsky review article see "Do Financial Conflicts of Interest Bias Research? An Inquiry into the "Funding Effect" Hypothesis."[8]

A much more common concept related to funding-induced bias is financial conflict of interest (FCOI). Ironically several federal funding agencies require disclosure of FCOI but federal funding is not included; rather the concept is restricted to commercial funding.

Google Scholar search for "FCOI" in titles for the period 2010-2014 gives zero hits. However it does find 186 occurrences in searching the full text, which suggests some research interest. Searching for the full phrase "financial conflict of interest" gives just 9 hits in titles, but over 5,000 in full text. These appear to be mostly research on either biomedical or professional activities. But as already mentioned, the term appears to be restricted to commercial financial interests, not Federal interests.

Searching on the broader concept phrase "conflict of interest" gives over 600 occurrences in titles. However, most the top hits appear to be either guidance or disclosures, not research on conflict of interest. Full text search gives over 240,000 hits. This very large number appears to be the effect of widespread conflict of interest policies, such that many articles include conflict disclosure clauses.

Conclusion: That federal funding might induce research bias seems to be a neglected research topic.

Research Directions and Prospects for Quantification

There are numerous ways in which the research offices in Federal agencies say what they are looking for. These are probably some of the best sources of evidence of bias in

agency research funding.

Examples include strategic plans, requests for proposals and clarifications or amendments thereto, scientific conference presentations by office, program or project officials, pre-proposal conferences, as well as agency or program reports on the science, especially in relation to their mission.

Analysis of these sources is likely to be interpretative and opportunities for quantitative analysis may be limited. However, an example of a quantitative analysis might be the amount of text devoted to a hypothesis that supports an agency mission or policy, compared to the amount given to a competing hypothesis. Another might be patterns of occurrence of apparently biased statements in multiple sources. Where the documents include funding levels there is also the possibility of finding monetary measures of bias.

Climate Debate Example

Example: controversy over the USGCRP Strategic Plan 2012-2021.[9] This plan has been criticized for promoting Federal policies rather than pursuing climate science. See, for example, the 2011 criticism by Judith Curry, then Chair of the Department of Environmental and Atmospheric sciences at Georgia Tech, who describes the Strategic Plan as "off the rails."[10]

3. <u>Biased peer review of research proposals</u>.

Concept Analysis

This bias may involve rejecting ideas that appear to conflict with the established paradigm, funding agency mission, or other funding interest. See also Bias #6: Biased peer review of journal articles and conference presentations.

Literature Snapshot

Peer review bias is the subject of considerable public discussion in the scientific community, as well as extensive scientific research. However, peer review is also used in the selection of papers to publish in scholarly journals and much of the discussion does not distinguish between peer review of proposals and articles. Thus there is some overlap between the Literature Snapshot provided here and that given under Bias #6 (Biased peer review of journal articles and conference presentations).

A Google Scholar search on articles published 2010-2014 with "peer review" in the title gives about 3000 hits, which suggests a great deal of research. To be sure, some of these hits are false in the sense of not being analyses of peer review, but bias is mentioned

frequently in the snippets so a lot of the research is focused on that topic. It appears that most of this research is focused on publications, not proposals.

Full text search gives over 200,000 hits. This large number suggests that the term "peer review" probably occurs frequently in passing. A major review of peer review bias that covers both proposals and publications was published by Lutz Bornmann.[11] Google Scholar lists 120 citations for this article so it is widely recognized.

Research Directions and Prospects for Quantification

Unfortunately, the peer review process is typically not publicly available. This is especially true for those proposals that are rejected. Nether the proposals or the reviews, or even the names of the reviewers, are typically available for bias analysis.

One might be able to arrange with the agency to gain access to this secret data, especially if the scientific issue in question is quite narrow. A Congressional inquiry is also a possibility, although this sets up an adversarial relation with the agency. Another possibility is to work with the agency's Inspector General.

Thus the prospects for bias research might be limited in this case, because of the secrecy, or they might involve indirect methods. For example, one might survey the researchers in the pool of candidates from which the reviews for a given program or project are likely to have been drawn, looking for evidence of bias.

In any case the prospects for simple quantification would seem to be limited, with a lot of interpretation required. Simply getting good data is the first research challenge.

Climate Debate Example

Allegations of this sort of bias have been made in the climate change debate. There is some concern that some funding agencies may be selecting reviewers specifically to further the agency's policy agenda. A Google search on "climate pal review" (without the quotation marks) will give some examples of these allegations as well as the debate over this issue. See for example the allegations of Battig.[12]

4. <u>Biased selection of research proposals by the agency program</u>.

Concept Analysis

The selection of proposals is ultimately up to the agency program officers. As with the selection of peer reviewers, there is some concern that some funding agencies may be selecting research proposals specifically to further the agency's policy agenda.

Literature Snapshot

A Google search on "biased funding of proposals" reveals some research on bias in proposal selection. However, it appears to be mostly focused on issues other than agency missions and policies. Topics include racial bias, gender bias and avoiding risky projects.

Google Scholar gives about 25,000 hits for documents containing all three of the terms "proposal", "funding" and "bias" in full text, for the five year period 2010-2014. Some of these relate to bias in selecting proposals for funding. However, as with the Google search, the focus seems to be on forms of bias other than government funding. This appears to be a gap in policy related research.

Research Directions and Prospects for Quantification

When a proposal is selected for funding there is some form of public notice, which can be used for bias research. However, the amount of information give may vary from agency to agency, ranging from a mere abstract to the entire technical proposal. The amount of funding is almost always disclosed. Some agencies provide compilation of funded proposals, which may facilitate comparisons and the search for funding patterns that might suggest bias in selection.

Unfortunately the many proposals that are not funded are seldom made available. This secrecy makes it much more difficult to look for bias in proposal selection. After all, bias can be as much a matter of which proposals are not selected as it is about which are selected.

Given that dollar amounts are involved there is the potential for quantification of bias in funding. There is also the matter of the number of proposals funded and other measurable features of selection. This might include who receives how much funding, what the funding is for, etc. All things considered the potential for quantification is relatively high for some aspects of bias in proposal selection. The fact that there is little information available about the many proposals that are not selected is certainly a hindrance.

Climate Debate Example

Allegations of this sort of bias have been made in the climate change debate. A Google search on the terms "climate change funding bias" (without quotation marks) gives the flavor of the debate. See for example the work of Michaels.[13]

5. Preference for modeling using biased assumptions.

Concept Analysis

The use of computer modeling is now widespread in all of the sciences. There is a concern that some funding agencies may be funding the development of models that are biased in favor of outcomes that further the agency's policy agenda.

Literature Snapshot

Unfortunately, "bias" is a technical term in the modeling literature, making it difficult to find studies that are looking specifically at funding related bias. Google Scholar estimates about 230,000 hits in the five year period 2012-2014 for studies using both "bias" and "modeling" in their text.

Adding the term "politically" reduces the hits to about 16,000 but these appear to be mostly modeling political processes, not looking at political bias in modeling itself. Many are focused on media bias. The same appears to be true for Google searches.

By the same token, Google Scholar search on "flaws" and "modeling" finds about 22,000 studies but most appear to be about modeling flaws, not flaws in modeling.

Google Scholar full text search on "incorrect model" gives about 2,900 hits but these appear to be mostly technical discussions of modeling or specific models, unrelated to possible funding bias.

There appears to be very little scientific research on potential funding-induced bias in the construction or use of scientific models. This is surprising, given the extent to which models are used in developing and defending Federal policies. This appears to be a major gap in policy-related research. It is possible that a lot of research on biased models is being done in connection with providing comments on proposed regulations and similar policy efforts, where these are based on modeling, but Google and Google Scholar do not cover these document domains.

Research Directions and Prospects for Quantification

Assessing funding bias in computer models may be difficult, for several reasons. These models can be very complex and technical. They also may be proprietary, or only run on very large computers. These difficulties may explain the apparent lack of research on funding-induced bias.

One approach might be to mine the technical discussion of the model or models in question, as well as the model documentation. The modelers may even be openly biased. Here the primary challenge may be to relate the bias to the agency policy or paradigm in question. The policy literature may be useful here, especially comments criticizing policy proposals that are based on modeling results.

Where the model code is available it may be possible to run it using assumptions that differ from those supporting the agency mission or actions. Or it may be possible to develop an alternative model. Even a relatively simple model can indicate that a more complex model is biased. In some cases there may even be multiple models giving different results. It may also be possible to find modelers who are familiar with the code and who know where biases may be hidden. But due to the highly technical nature of models this may be a difficult line of research.

Note too that modeling bias may be due to the selection or manipulation of input data, rather than to the construction of the model itself. Looking at the input data is a different research approach.

As for quantification, while computer models are mathematical, the assessment of model bias may not be statistical in nature. The goal may be to quantify the magnitude of the bias, rather than the frequency of its occurrence.

Climate Debate Example

Allegations of this sort of bias have been made in the climate change debate, where models play a prominent role in supporting Federal policy. A possible example is the climate modeling used to develop the federal government's Social Cost of Carbon.[14] This effort has been the subject of a large scholarly literature, as well as extensive public policy discussions, regarding possible bias in various assumptions used in the modeling. A Google search on "Social Cost of Carbon" (without the quotation marks) will provide an introduction to this debate. A Google Scholar search on the term "Social Cost of Carbon" yields over 4,000 technical works.

6. <u>Biased peer review of journal articles and conference presentations</u>.

Concept Analysis

This issue is analogous to the potential bias in peer review of proposals, as discussed above. As in that case, this bias may involve rejecting ideas that conflict with the established paradigm, agency mission, or other funding interests.

Literature Snapshot

Peer review bias is the subject of considerable public discussion in the scientific community, as well as extensive scientific research. However, peer review is also used in the selection of proposals to fund and much of the discussion and research does not distinguish between peer review of proposals and articles. Thus there is some overlap

between the snapshot provided here and that given under Bias #3 (Biased peer review of research proposals).

A Google Scholar search on articles published 2010-2014 with "peer review" in the title gives about 3000 hits, which suggests a great deal of research. To be sure, some of these hits are false in the sense of not being analyses of peer review, but bias is mentioned frequently in the snippets so a lot of the research is focused on that topic. It appears that most of this research is focused on publications, not proposals. Full text search gives over 200,000 hits. This large number suggests that the term "peer review" probably occurs frequently in passing.

Much of the research into biased peer review occurs within the biomedical community. In part this is probably because issues affecting health and medicine can be quite serious. In addition, biomedicine is a very large research area, compared to the other specialties within science. For example, the US Federal basic research budget for NIH is larger than the combined budgets for all other forms of basic research.

The biomedical community even has a regular gathering on the issue of peer review and publication. This is the "International Congress on Peer Review and Biomedical Publication" which is held every five years. The Seventh Congress was held in 2013, with 47 presentations and 63 posters.[15]

Research Directions and Prospects for Quantification

Biased peer review of articles submitted to journals is already an active research area, so the primary challenge is to focus on the Federal policy or paradigm-supporting aspect. Unfortunately, just as with proposals, the journal peer review process is typically not publicly available. This is especially true for those articles that are rejected.

Nether the submissions or the reviews, or even the names of the reviewers, are typically available for bias analysis. There are beginning to be exceptions to this secrecy. Some journals are even making the reviews public, especially for the accepted articles.

One might be able to arrange with the publisher to gain access to this secret data, especially if the scientific issue in question is quite narrow. Journals have probably become sensitive to the issue of bias. In many cases this issue might fall to the editorial board, not the publisher. They might even welcome some analysis.

Thus the prospects for bias research might be limited in this case, just as in the case of proposals, because of secrecy. Or the bias research might involve indirect methods.

For example, one might survey the researchers in the pool of candidates from which the reviews for a given journal are likely to have been drawn, looking for evidence of bias. A journal might even make its reviewer list available for analysis, when it will not do so for individual articles.

Suppose one has the journal's list of reviewers and there is a related controversy regarding an agency's policy or paradigm. If the relevant reviewers can be classified according to their position on the controversy, then the list can be tested for its balance of representation. Of course this assumes that all reviewers carry equal weight so it is a relatively rough test. For example, in the case of the climate change debate one could look for skeptics versus firebrands on the reviewer list.

In any case the prospects for simple quantification would seem to be limited, with a lot of interpretation required. Getting good data is the first research challenge.

Climate Debate Example(s)

Allegations of this sort of bias have been made in the climate change debate. A Google search on "climate change peer review bias" (without the quotation marks) gives the flavor of this debate. For example, see works by Pielke,[16] McKitrick,[17] and Michaels.[18] [19]

It might be useful to have conferences on this climate debate issue along the lines of the "International Congress on Peer Review and Biomedical Publication" described above.

7. <u>Biased meta-analysis of the scientific literature</u>.

Concept Analysis

Meta-analysis refers to studies that purport to summarize a number of research studies that are all related to the same research question. For example, meta-analysis is quite common in medical research, such as where the results of a number of clinical trials for the same drug are examined.

Literature Snapshot

There is a sizeable literature in at least two fields on bias in meta-analysis, clinical medical trials and psychology. Some sample articles include work by Mueller et al[20] and by Ferguson and Brannick.[21]

Research Directions and Prospects for Quantification

Given that meta-analysis bias is already a significant research area, the challenge is primarily to adapt it to the realm of funding-induced bias. This would seem to be primarily a matter of doing three things. First, choose the meta-analytical document or documents to be analyzed. Second, identify the specific bias to be analyzed for, and then compare the available literature with that chosen for the meta-analysis.

The first choice for meta-analyses to be analyzed might well be documents produced by, or funded by, the funding agency. This is especially true for documents specifically designed to support agency policies. Scientific review articles related to hypotheses which support agency policies are another likely candidate. In some cases the potential bias itself will dictate which documents should be analyzed for bias.

It is not clear that quantification can play a major role in this sort of bias research. For example, if a meta-analysis is found to be ignoring scientific papers reporting negative results, how many such papers there are may not be the issue. This may be more a matter of the strength of evidence, not a matter of counting up the sides.

Climate Debate Example(s)

The periodic reports made by the IPCC are prime examples of meta-analyses in the climate debate. So are various reports produced by the USGCRP. In both cases there have been allegations of biased selection of the articles used in the meta-analysis. A Google search on the term "IPCC bias" (without the quotation marks) gives an introduction to this widespread debate.

With regard to the USGCRP, a good example is an extensive criticism of the 2009 version of their report "Global Climate Change Impacts in the United States"[22] in "ADDENDUM: Global Climate Change Impacts in the United States" by Michaels et al.[23]

8. <u>Failure to report negative results</u>.

Concept Analysis

This topic has become the subject of considerable public debate, especially within the scientific community. Failure to report negative results can bias science by supporting researcher that perpetuates questionable hypotheses.

Literature Snapshot

There is a considerable literature on this topic, often under the heading of publication bias. Google Scholar full text search on "publication bias" for 2010-2014 gives over 22,000 hits, while title only search gives 236 hits. This bias is also termed "reporting bias" with 93 Google Scholar title hits and over 18,000 full text hits. These are relatively large numbers, indicating significant research activity.

There is a plain-language listing of related bias types, with good references, from the blog

Editage Insights: "Publication and reporting biases and how they impact publication of research" by Velany Rodriguez.[24]

Research Directions and Prospects for Quantification

Given that publication bias is already an active research area; the primary challenge is to look for bias that is related to agency funding or which supports agency policy needs. Thus the starting point is probably the agency policy or paradigm.

Journals are not normally federally funded,[25] but they may well be involved in or sensitive to Federal policies. This is likely to be especially true in the applied fields. An example might be renewable energy research. There is also the case of open access or hybrid journals where author publication charges are paid out of Federal grants.

A lot of this research is quantitative because it looks at bodies of research results, rather that at individual results. Publication bias is typically a pattern, not a single action. The scope may vary from a single journal up to an entire field.

Climate Debate Example(s)

The extensive controversy over the so-called "Hockey Stick" climate change graphic and the allegations that it deliberately "hides the decline" in certain data that is not presented.

9. Manipulation of data to bias results.

Concept Analysis

Raw data often undergoes considerable adjustment before it is presented as the result of research. There is a concern that these adjustments may bias the results in ways that favor the researcher or the agency funding the research.

Literature Snapshot

A full text search Google Scholar on "data manipulation" for the five year period 2010-2014 yields about 19,000 results. However, it appears that most of these are about tools and methods for benign data processing. A few address manipulation as a form of bias, including the manipulation of data by governments, for policy purposes.

A full text search for all three terms "government" and "data" and "manipulation" gives about 44,000 hits, with some clearly being about biased manipulation, including policy related biases.

Thus there is an ambiguity in the use of the term data manipulation. Sometimes it refers

to benign data processing but at other times it refers to questionable manipulation. However, it is clear that there is a significant body of research into the latter, which means the biased form of data manipulation.

Another approach to the literature is from the direction of scientific fraud, even though bias need not be fraudulent. A full text search on "fraud" and "data manipulation" for the period gives about 1,200 hits. Searching on "fraudulent" and "data manipulation" gives over 6,000 hits. Clearly the scientific community is concerned about fraudulent data manipulation and this is a significant research area.

The kind of funding-induced bias we are concerned with here falls somewhere in between benign data processing and outright fraud. While that middle ground exists in the literature it is not easy to find. Clearly this is a complex issue with a burgeoning literature.

Research Directions and Prospects for Quantification

Given that there is already active research into possible bias in data manipulation, the principal challenge seems to be to focus some research on possible cases of funding-induced manipulation. It is likely that this research will involve specific cases, rather than statistical patterns. However, the manipulation itself will often be quantitative.

Climate Debate Example

There are a number of prominent cases of allegations to this effect in the climate change debate. An example is the public controversy over NOAA (and NASA) historic temperature data "adjustments." Relevant articles include works by Goddard,[26] Curry,[27] and Watts.[28] [29]

10. Refusing to share data with potential critics.

Concept Analysis

A researcher or their funding agency may balk at sharing data with known critics or skeptics.

Literature Snapshot

Data sharing is a major topic of research and discussion within the scientific community. Google Scholar returns about 29,000 full text hits for "data sharing" for the five year period 2101-2014. Searching on titles gives about 1,600 hits. These are relatively large numbers.

Many of these articles are related to policy issues promoting data sharing, while many others are about specific cases, especially data repositories. (There is also a different use of the term, related to the design of computer network systems.)

There appears to be little work directly focused on not sharing data, especially for policy related reasons, although the general topic of not sharing data may be discussed in passing in articles promoting data sharing. In fact a full text search on "not sharing data" returns about 160 hits. Many of these articles are reporting surveys exploring researcher's reasons for not sharing their data.

There are, however, some well known cases of scientists refusing to share policy relevant data. In the US one of the most prominent is the so-called Six Cities study regarding the long term health effects of airborne fine particulates. See for example the work of Kabat.[30] A Google search on "Six Cities study controversy" (without the quotation marks) provides many additional sources.

It appears that despite these prominent cases there is relatively little research into the practice of refusing to share data that is used to support Federal agency policies.

Research Directions and Prospects for Quantification

Research in the area of refusing to share data because of its policy implications might be largely anecdotal. That is, one might look for allegations. Another possible approach might be to analyze agency Freedom of Information requests, to see how many pertained to attempts to get policy relevant data. Here the results might well be quantitative.

Climate Debate Example(s)

There are several prominent examples of researchers refusing to share important climate data with skeptics. One of the best known involves the University of East Anglia. See for example: "University of East Anglia refused to share information on global warming."[31]

11. <u>Asserting conjectures as facts</u>.

Concept Analysis

It can be in a researcher's, as well as their funding agency's, interest to exaggerate their results, especially when these results support an agency policy or paradigm. One way of doing this is to assert as an established fact what is actually merely a conjecture.

Literature Snapshot

Speculation is a widely used term. Google Scholar lists over 1300 occurrences of "speculation" in titles for the period 2010-2014. These appear to be mostly studies related to forms of financial speculation. Search for the term occurring anywhere in the text during this period gives over 70,000 hits, many of which are probably incidental.

Narrowing the term to "scientific speculation" gives about 800 full text hits, just 5 in titles. Here there is interesting work in the computational biology community using semantic analysis to try to identify speculative statements. These approaches may well be applicable to the problem of speculation presented as fact.

Much of this semantic research also uses the term "speculative statements" and Google Scholar search on that term gives about 240 occurrences in full text and 2 in titles, for the period. Many of these occurrences appear to be from this relatively small research community. A sample article is by Malhotra.[32]

Research Directions and Prospects for Quantification

The bias of asserting conjectures as facts is largely semantic in nature. It can occur anywhere in the life cycle of research, from agency documents to journal articles and media reports. It is basically a form of hype, but with an epistemic dimension, claiming to know what is in fact not known.

There are various forms of semantic research that might be used to look for this bias in relation to agency policy. In a simple case one might first isolate key claims that are controversial, look for patterns of assertion that express them as settled. One might also look for the inclusion of policy prescriptions in the statement of the science.

A broader analysis might look at the language being used in presenting the science. Good scientific writing is carefully crafted to be cautious. Terms like suggests, possibly, likely, may, might, etc. occur frequently when conclusions are stated. The lack of this sort of qualifying language might be diagnostic for the bias of asserting conjectures as facts. Semantic techniques like term vector similarity might be useful here.

A lot of semantic analysis is quantitative in nature, especially when terms or occurrences are being counted. This is likely to be the case when one is gauging the level of confidence.

Climate Debate Example(s)

There are numerous allegations to this effect in the climate change debate. In fact there is a broad general issue that is often phrased as to whether or not the science is settled. A Google search on the term "climate science is settled" (without the quotation marks) provides a good introduction to this debate, with numerous voices on both sides of the issue.

Example: Judith Curry has written extensively about this issue, especially on her blog Climate, Etc, with regard to the IPCC.[33] [34] A search of http://judithcurry.com for the term "overconfidence" leads to numerous articles on this topic.

12. <u>False confidence in tentative findings</u>.

Concept Analysis

Another way for researchers, as well as their funding agencies to exaggerate results is top claim that they have answered an important question when the results merely suggest a possible answer. This often means giving false confidence to tentative findings.

Literature Snapshot

Google Scholar reports about 2500 articles using the exact term "false confidence" in the 2010-2014 time period. However, this term occurs just 5 times in article titles, suggesting that the concept per se is not a focal point for research.

Some are using the term in passing, but in many cases this concept is the point of the analysis. However, these analyses appear to be mostly narrative, with little quantification. In many cases the article is of an editorial nature, see for example Michaels.[35]

All in all it seems that there is relatively little scientific research on the problem of false confidence, even though it is widely discussed.

Research Directions and Prospects for Quantification

As with the bias of asserting conjectures as facts, the bias of false confidence is semantic in nature. It can occur anywhere in the life cycle of research, from agency documents to journal and media reports. It is basically a form of hype, but with an epistemic dimension, namely claiming an unjustified weight of evidence for a given finding.

Moreover, as with hype in general, one can look at how results are reported in the media or in press releases, compared to how they are stated in the journal.

A lot of semantic analysis is quantitative in nature, especially when terms or occurrences are being counted. While this seems not to have been done for the problem of false confidence bias in the reporting of research, there is no obvious reason why it cannot be done.

Climate Debate Example(s)

There are numerous allegations to this effect in the climate change debate. For example, there is a long history of individual studies (or the reports of them) claiming to have proven that humans are responsible for the observed global warming. In climate science this question is called the attribution problem. Skeptics argue that the attribution problem has yet to be solved, and certainly not by any single study.

A more recent example might be the numerous studies (or reports thereof) which claim to have explained why there has been no statistically significant warming for over two decades.[36] This is sometimes called the problem of the pause, or the hiatus in global warming. Various inconsistent explanations have been offered, so it is likely that most are incorrect, yet each is often presented as though it solved the problem. See for example the work of Watts.[37] A Google search on "global warming pause" (without the quotation marks) gives further examples.

13. <u>Exaggeration of the importance of findings by researchers and agencies</u>.

Concept Analysis

Researcher and agency press releases sometimes claim that results are very important when they merely suggest an important possibility, which may actually turn out to be a dead end. Such claims may tend to bias the science in question, including future funding decisions.

Literature Snapshot

A Google Scholar full text search on "exaggeration" and "press releases" gives over 17,000 hits for the period 2010-2014. Oddly there are just two hits for the combination of these terms in titles, but many of the text hits are in fact on studies of press releases and exaggeration, including in science. Thus this is an active research area, including studies of press releases about scientific findings.

For the related terms "science" plus "hype" Google Scholar gives over 16,000 hits in a full text search for the period 2010-2014. Many are looking at specific cases where hype may be an issue, often with a theme of "hope or hype." However, the title search returns just 9 hits, a further indication that this language is primarily found in articles about specific cases of possible hype, not in studies of the occurrence of hype in science. A useful introductory article is by Rinaldi.[38]

Note that our different types of exaggeration-related bias are not always distinguished. Thus the number of articles related to each type may be greater than is indicated by the Literature Snapshots.

Exaggeration of importance is a third type of misrepresentation, along with presenting speculation as fact and presenting tentative findings with false confidence. Unlike the other two, exaggeration of importance is about the future more than the findings. It is basically a claim about the future direction that science will take because of the findings being reported.

As with the other types of exaggeration, this is also semantic in nature (but without so much of the epistemic dimension). Because it is forward-looking it is likely to be characterized by future tense statements, which may even be a semantic basis for finding candidate statements. However, the prospects for quantification are unclear, because this seems to be more a case of specific instances, rather than a pattern of bias.

Climate Debate Example(s)

Exaggeration is a major issue in the climate change debate. In fact skeptics often refer to their opponents as "alarmists." A Google search on "climate change exaggerated" (without the quotation marks) provides a glimpse of this widespread debate.

14. <u>Amplification of exaggeration by the press</u>.

Concept Analysis

The bias due to exaggeration in press releases and related documents described above is sometimes, perhaps often, amplified by overly enthusiastic press reports and headlines.

Literature Snapshot

Google Scholar gives over 5000 hits for "media bias" 2010-2014 with 163 in the title. This literature appears to be found mostly political science, economics and communications journals, with a focus on political cases.

However, a full text Google Scholar search on the co-occurrence of the three terms "exaggeration," "science" and "news" for the same period gives over 18,000 hits (with just one occurrence in a title). A significant fraction of these many articles are exploring media exaggeration of scientific reports. Note too that some of the articles returned on searches related to our other types of exaggeration-related bias may address media bias as well.

Research Directions and Prospects for Quantification

The existing media bias research is a good model for research into funding related bias. What needs to be done in some cases is to change the focus from political bias to policy bias. This is not a stretch as the two are relatively closely related. Policy is often the outcome of the political process.

Looking for paradigm supporting bias in scientific reporting may be more difficult. Here it will be necessary to carefully consider the scientific controversies that relate to a given agency's policies. This sort of bias may be more subtle than overt political bias. Nevertheless, the existing research into media bias looks to be a good model.

Some of the existing research is quantitative in nature, but much is not. A lot of it seems to be interpretative. An interesting issue here is whether bias and hype come mostly from the media or from the original press releases. A recent quantitative study by Sumner illustrates a useful approach.[39]

Climate Debate Example(s)

As with hype in general, alleged press bias is a major topic in the climate debate. Google searches on "climate change media bias" and "climate change media hype" (without the quotation marks) will give the flavor of this widespread debate topic.

15. <u>More funding with an agenda, building on the above, so the cycle repeats and builds</u>.

Concept Analysis

The biased practices listed above all tend to promote more incorrect science, with the result that research continues in the same misguided direction. Errors become systemic by virtue of a biased positive feedback process. The bias is systematically driven by what sells, and critical portions of the scientific method may be lost in the gold rush.

Literature Snapshot

There appears to be very little research looking at systematic linkages between combinations of the types of bias identified above, and subsequent funding. Some of these types of bias are attracting considerable research on an individual basis, but not in relation to subsequent agency funding.

However, the concept that perverse incentives are damaging science is getting some discussion in the scientific community. See, for example, popular work of Schekman[40] and of Michaels.[41]

In this case one is probably looking for funding that occurs after the other types of bias, where the prior bias supported the funding agency's mission, policy or paradigm. Quantification is certainly plausible, especially given that dollars are one of the measures.

Climate Debate Example(s)

As the examples in preceding bias sections make clear, it has been alleged that leading researchers whose findings support US climate policy have been rewarded with continuing, or even increasing, Federal research grants because of systemic bias.

VII. Some Conclusions and Observations

Some types of bias are being studied extensively and quantitatively, while other remain largely unresearched. Various aspects of peer review and publication bias, especially in biomedicine, appear to be the most heavily researched types of bias.

The role of funding in inducing bias is frequently alluded to as a potential financial conflict of interest. But it is not the focus of most research, which tends to look more at the practice of bias than at its cause. A new research thrust is likely needed.

The role of government funding in inducing policy-driven bias seems to have received very little attention, even though it may be widespread. There are certain exceptions, most noticeably in the climate change debate and environmental policy in general. But here the attention is more a matter of public concern than one of quantitative scientific research.

Cascading Amplification of Funding-induced Bias

In this report we have mostly been concerned with individual types of funding-induced bias. But there is an intrinsic sequence to the various biases we have identified that raises the possibility of cascading amplification. By amplification we mean one biased activity is followed by another, such that the first bias is increased by the second.

A simple, and perhaps common, example of amplification might be when the hype in a press release is exaggerated in a news story. Assume, for example, that the press release overstates the importance of a research result, but with some qualification. The news story then reports the result as a great breakthrough, far more strongly than the press release, ignoring the latter's qualifications. In this way the original bias has been amplified.

There is also the possibility of cascading amplification. This is the case where an initial

biased activity is followed by multiple or successive instances of amplification. Using our example, suppose a single biased press release generates many different news stories, which vie with one another for exaggeration. This one-to-many amplification is properly termed a cascade.

Moreover, there is the possibility of cascading amplification on a very large scale and over multiple biased stages. Here is an example of how it might work.

1) An agency receives biased funding for research from Congress, and

2) it issues multiple biased Requests for Proposals (RFPs).

3) Multiple biased projects are selected for each RFP.

4) Many projects produce multiple biased articles, press releases, etc.

5) Many of these articles and releases generate multiple biased news stories, and

6) The resulting amplified bias is communicated to the public on a large scale.

One can see how in this instance a single funding activity, the agency budget, might eventually lead to hundreds or thousands of hyperbolic news stories. This would be a very large scale amplification cascade of funding-induced bias.

Climate Change Examples

In the climate change debate there have been allegations of bias for each of the stages described above. Taken together this suggests the possibility that just such a large scale amplifying cascade has occurred or is occurring. But systematic research might be needed to determine if this is actually the case.

Conclusions

The notion of cascading systemic bias, induced by government funding, does not appear to have been much studied. This is a big gap in the research on science and public policy. Moreover, if this sort of bias is indeed widespread then there is a serious need for new policies to prevent it, both at the Federal level and within the scientific community itself.

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[1] http://energy.gov/eere/renewables/solar.

[2] http://nca2014.globalchange.gov/

[3] See for example:
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http://www.cato.org/publications/commentary/national-climate-assessment-report-raises-false-alarm

"What the National Climate Assessment Doesn't Tell You" (May 5, 2014)
http://www.cato.org/blog/national-climate-assessment-doesnt-say

"Cato's Impact Assessment" by Judith Curry (July 23, 2012)
http://judithcurry.com/2012/07/23/catos-impact-assessment/ (with 621 comments)
Discusses a draft of the ADDENDUM, listed below.

"ADDENDUM: Global Climate Change Impacts in the United States" by Michaels et al
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[14] http://www.epa.gov/climatechange/EPAactivities/economics/scc.html for coverage of the model.

[15] http://www.peerreviewcongress.org/index.html.

[16] http://wattsupwiththat.com/2011/04/20/bias-in-the-peer-review-process-a-cautionary-and-personal-account/ by Roger Pielke, Sr.

[17] http://rossmckitrick.weebly.com/uploads/4/8/0/8/4808045/gatekeeping_chapter.pdf by Ross McKitrick.

[18] "Peer Review And 'Pal Review' In Climate Science" by Patrick Michaels
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