Scientific Elites as Policy Entrepreneurs:
Is There a Role for Scientists in Congressional Climate Change Policy?*

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Abstract

This paper examines the role of science in climate policy by analyzing the causal relationship between scientific activity and policy-makers' attention to climate change. Quantitative analysis of the level of scientific activity, measured in number of climate-related National Research Council reports (1975-2005), and Congressional committee hearings on climate policy helps uncover the simultaneous interaction between science and policy. While scientific activity affects the policy agenda, it fails to generate greater institutional attention to the problem of climate change. Results indicate that changes in the attention of Congressional policy-makers to climate issues are likely to follow from the 'policy stream', rather than from scientific publications. The role of scientists in climate debates remains one of simple inventors, as opposed to the more powerful ones of policy entrepreneurs and agenda-setters.

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"…scientific practice is inherently political, because scientists help define a large part of what is taken for granted by billions of people – a type of influence that in some respects is the ultimate form of authority." (Cozzens and Woodhouse 1995, 551)

I. Introduction:

What role does scientific expertise play in the policy process? How do scientific elites influence public policy in a pluralist democracy? Can science serve the needs of social problem solving, and how can we use the increasing stock of expert knowledge as a basis for institutional action in the political debate on global warming?

The United States climate change policy has been described as "debate and discord" politics (Fisher 2004, 121). Substantial incongruence between the front-line contributions of climate scientists and the reservations of policy-makers to international commitments and regulation has marked the state of affairs in this area. Why has an important policy issue, such as climate change been pioneered by scientists but overlooked by Congressional policy-makers? Is there a role for scientists in the present-day American political system?

The question of whether opinion (*doxa*) or knowledge (*epistémé*) should "steer the ship of state" dates back to Plato's critique of Athenian democracy (Plato 2003, 404). Plato depicts epistémé as a crucial, yet incompatible component of democratic principles and practice. Today, the political conundrum remains (Holden 2002, Byrne and Yun 1999). How do we reconcile the recommendations of scientific "guardians"[1] with the opinion of citizens in substituting individual with collective choice? How do we channel scientific research to improve policy-making, especially in areas of high technical expertise, while at the same time preserving popular control and democratic values?

This paper examines the role and relative influence of science in the policy process. The substantive content of the analysis – US climate change policy – reflects the characteristic glitches between scientists and policy-makers. By examining the interaction between science and policy, the paper sheds light on the legitimacy and role of science in policy-making. Specifically, it seeks to uncover the impact of scientific research on Congressional attention to climate change by accounting for the simultaneity in the science-policy relationship.

In what follows science[2] will refer to the community of elite scientists in the field of climate change. To use Arnold's terminology these are "professionals who investigate causal chains as part of their jobs" (1990, 21), or in Kingdon's view – natural and social scientists who share "common specialization and acquaintance" (1995, 200). More precisely, scientific elites are mediators between bench scientists and policy-makers "active in…policy making and influential among their professional colleagues" (Mulkay 1976, Hart and Victor 1993, 644).

The paper is organized as follows: First, a review of relevant theoretical perspectives is provided. Next, the research question, data and quantitative analysis methods are presented. An analysis and discussion of the results follows. Finally, the conclusion summarizes the main findings of the paper.

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[1] Plato's idea of guardianship or government by a minority of experts has served as a central critique to democracy. According to Plato government (or policy-making) is a matter reserved for people with knowledge (episteme). Because only a few possess knowledge, they and not the masses should rule.

> *"Scientists can no longer afford to be naive about the political effects of publicly stated scientific opinions. […] Once scientific opinion enters into the public domain, the possibility of political neutrality disappears, but this does not mean that objectivity has to be thrown in the winds."* (Brooks 1976, ix)

II. Theoretical Linkages:

Several theoretical perspectives contribute to our understanding of the role of science in the policy process – specifically, group theory (Olson 1971), interest group mobilization (Stone 2002), agenda setting (Kingdon 1995), and the science and technology studies (Jasanoff 1990).

The interaction between scientific communities and policymakers is often described as one of mutual influence. Harvey Brooks styles this relationship as two distinct concepts: "science in policy" and "policy for science" (1964, 76). On one side, Congress affects scientific research through funding and oversight, for instance establishment of programs/institutes, such as the Climatic Impact Assessment Program (1976). On the other, scientists are key actors in congressional testimonies and hearings. This paper examines the impact of scientific research on the climate change agenda of Congress. It adopts the 'science in policy' view, seeking to account at the same time for the simultaneity in the science-policy relationship.

What role does scientific expertise play in democratic decision-making? Some believe that scientists "should not be enfranchised to formulate the problems or decide on the goals that a policy should address" (Campbell in Weiss 2000:293). This view associated with the works of Campbell (1988) and Lindblom (1979) stands in contrast to the Platonic idea of 'guardianship'. Public opinion, not science and reason govern public policy in a democracy; the opposite will

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[2] The terms *science, scientific research expertise, scientific community/elites* will be used interchangeably here.

only be possible at the cost of democratic values (Weiss 2000, 286). Lindblom sums this bluntly: “If a society wants more reason and analysis in policy making, perhaps it must surrender some aspects of democracy.” (1993,12). In a similar spirit Barry Holden writes that the nature of global warming makes democratic decision-making “fundamentally unsuitable” (2002, 30).

How can we then preserve democracy, public representation and popular control in areas that are increasingly reliant on scientific expertise? How does science manage to effectively surface and contend with other group interests in the policy process? It is important to understand the conditions under which scientific communities actively engage in policy advocacy. Political scientists explain why certain interests manage to mobilize more successfully than others (Olson 1971). Interest group mobilization is useful in understanding how scientific expertise[3] finds expression in public policy. According to Stone (2002, 217) mobilization is “the process by which effects and experiences are converted into organized efforts to bring about change”. The question that ensues is how the work of climate scientists converts into an organized activity and advocacy to affect Congressional members’ attention to climate change?

Scientific efforts are preconditioned by interests, and most interests in the political realm concern collective goods. Credited to Mancur Olson (1971), group or collective action theory suggests that groups act to further the common interests of their members and obtain an optimal level of collective benefits. In the context of climate scientists such benefits are research funding, establishment of study centers, jobs, grants, acknowledgement, prestige, etc. Small groups are able to further their interests better than large groups, because social incentives operate more effectively in a narrow environment with face-to-face interactions, making free-

[3] That is different from scientific advisory committees’ collaboration with policy-makers.

riding and self-interested behavior less likely (1971, 76). In Olson's paradigm, climate experts are a "latent group" that can be organized through incentives, such as grants and jobs (p. 51-63).

Political scientists contend that selective incentives can also arise from the process of collective action itself. As Stone (2002, 219) puts it, "one plays even more just to play, and the greater satisfaction comes from being in the game". Increased scientific participation in the climate debate can set examples and incentives for others, thus generating a 'contagious' effect. In all probability, increased participation advances scientific knowledge, enhances a common view and builds consensus. Yet, Olson argues, that even in the presence of perfect consensus "there will be no tendency for the group to organize to achieve its goals" (1971, 60). Group theory, thus, suggests that the interests of climate experts are likely to remain diffused and their 'latent' power unrealized.

Another model purports to explain interest mobilization in terms of policy substance. Policy decisions impose different costs and benefits on the public (Wilson1980, Arnold 1990). The distribution and traceability of policy effects results in different incentives for interest mobilization. It can be expected that green-house gas regulations will have early-order, narrowly-concentrated economic costs, vis-a-vie late-order, widely-distributed benefits to society (Wilson 1980, Arnold 1990). The political contest born from the configuration of diffused benefits versus concentrated costs will leave the larger group of potential gainers (including scientific elites) passive, while the anti-regulation interests will organize strategically to defeat the imposition of costs. In essence, the diffusion of potential benefits inhibits interest mobilization (Wilson 1980).

In contrast to the expectations of group theory, pluralists recognize the potential of all interests to organize and participate in the policy process (Lowi 1979, 33). Interest group liberalism provides that the policy choices of legislators are guided by the legitimate demands of interest groups, channeled through such activities as lobbying, drafting of bills, campaign contributions, etc. Business, citizen, and scientific interest groups are, thus, all important actors in the climate debate. Yet, how can we explain the lack of Congressional action/ attention to the problem of climate change?

One proposition is the imbalance in interest group representation (e.g. inequality in resources, organization, etc.). As a result, some interests are better 'heard' than others; formal rules are replaced with informal bargaining; and, popular sovereignty and democratic forms are undermined (Lowi 1979). Indeed, the history of US climate policy presents a classic example of how the public interest can result in a sub-optimal political equilibrium. Scholars argue that contending forces behind interest group politics can often 'rob' policies of certain values, such as legitimacy, equality, and justice (Lowi 1979, 58; Stone 2002). Could *epistémé* be one of them? Why is the recent political equilibrium in the interest-group politics of climate change lacking in scientific reasoning?

Scholars point out that expert knowledge is often manipulated by both businesses and policy-makers. Science in the policy process is a strategic resource used by "knowledge brokers" to achieve their own goals (Lindblom 1979), or employed by agencies to enlarge their policy agendas (Jasanoff 1990). The STS literature shares a similar view of scientists as "hired brains of special interest and lobbyists" (Cozzens and Woodhouse 1995, 533). Science serves politicians by legitimizing their policy choices (Paterson 1996). Likewise, participants in the climate debate have mobilized scientific uncertainty as a means to further existing issue discords. Instead of facilitating consensus, science and scientific uncertainties can deepen technical debate and policy conflicts (Jasanoff 1990, Oreskes 2004, Sarewitz 2004, Pielke 2004). This leads scholars to challenge the capacity of science to advance rational policy-making and at the extreme to provide relevance for policy decisions (Collingridge and Reeve, 1986).

A different view is that of "science as politics by other means" (Paterson 1996, 152). It depicts scientists as self-interested actors who advance scientific claims in order to secure benefits (funding, jobs). Such a strategic-behavior approach is incorporated in the work of political scientists who study agenda-setting.

In Kingdon's agenda-setting model (1995), scientists surface both as specialists and entrepreneurs. Specialists are loosely-knit "hidden" participants, who interact with policy-makers through speeches, congressional hearings, press releases, and paper circulations, among others. Entrepreneurs, on the other hand, are described as lobbyists, academics, civil servants or elected officials engaged in problem definition, policy proposals or stream linkages (Kingdon 1995). Similarly, Hart and Victor (1993) define scientists as strategic policy entrepreneurs who use open policy windows to advocate their interests and secure resources.

Kingdon's agenda setting model (1995) furthers the 'garbage can model', formulated first by Cohen, March and Olsen (1972) [4]. It explains incremental policy-making in terms of separate, but simultaneously flowing streams of problems, solutions, participants and choice opportunities. Once generated, solutions and problems are dumped into 'garbage cans', from which policy participants later draw to formulate policy choices (Cohen, March, and Olsen 1972). According to Kingdon's modified 'garbage can' model, new policies are designed through the coupling of problems, policies, and politics. Events (e.g. heat waves, change in partisan context in Congress) or indicators (e.g. new scientific findings) can cause the three streams of problems, policies and

[4] Cohen, M.D., J. G. March, and J. P. Olsen. 1972. A Garbage can Model of Organizational Choice. *Administrative Science Quarterly* 17:1-25.

politics to merge, thus creating a 'policy window'. Open policy windows are opportunities for stream linkages, as well as for strategic behavior on part of policy participants, who can then devise policy packages and place them on the agenda of decision-makers (Kingdon 1995, 196-4).

To sum, the theoretical perspectives reviewed above do not provide for a strong role of science in climate policy. A number of factors account for this: the 'latent' community of climate scientists, the uncertainty in magnitude and timing of the benefits from carbon regulation, widely-distributed, broad benefits, long causal chains and weak traceability between policy instruments and effect, as well as concerns over democratic forms and popular control. Theory suggests that science often falls 'prey' of interest group politics. Uncertainty, persuasion, and science itself serve as powerful resources in the hands of policy-makers who manipulate them to gain public support and advance their own agendas. At a minimum, scientists are powerful entrepreneurs in Kingdon's agenda setting model.

"Never mind the answer: what's the question"[5]

III. The Research Question

As explained in the preceding section the ability to set the policy agenda is a source of political power in itself (Kingdon 1995). In the remainder of the paper, I propose to examine the capacity of scientists to influence the policy agenda of Congress as an indicator of their relative influence in policy-making. My research question is: *Can scientific elites be effective policy entrepreneurs, and if so, what is their relative power in climate change policy?* I adopt Hart and

[5] Gertrude Stein cited in Raynor and Malone 1998, 52.

Victor's view of scientific elites as policy entrepreneurs and mediators between bench scientists and legislators. Such an approach is justified on several grounds.

First, it is worth revisiting Hart and Victor's question (1993) within a more recent time-frame[6]. The goal is to unveil whether the validity of their findings holds over time. In their study of the role of scientific elites in US climate change research, Hart and Victor (1993) found that between 1957 and 1974 scientific policy advocacy was not vigorous; opportunities for agenda-setting came from unrelated policy issues, rather than from scientific findings; and the important mediation channels between bench scientists and the hearing room were ad-hoc group reports (NAS panels), rather than journal publications.

Second, it is important to try to operationalize some of the concepts, construct measures and quantitatively test hypotheses. The latter should help us gain a better understanding of the role of scientific elites – namely, whether scientists surface in the policy process simply as inventors or as policy entrepreneurs, as well. Finally, we should be able to tell the story of the relative power of scientists to bring the problem of climate change up on the agenda of Congressional decision-making.

The conceptual framework of the analysis is Kingdon's agenda-setting model, which describes scientists as policy entrepreneurs. As such, scientific elites can place policy issues on the legislative agenda. Aided by policy windows (events/indicators), scientists can contribute to stream linkages and issue (re)definitions. Their participation in the policy process can be motivated by concern with the problem of global warming, promotion of scientific evidence, gratification derived from participation in scientific discourse, as well as bids for individual and collective benefits (Kingdon 1995, Stone 2002, Oslon 1971).

The analysis that follows aims to illuminate the causal structure between scientific claims on the one hand, and the attention of Congressional policy-makers to the issue of climate change, on the other. Specifically, I examine whether the level of scientific activity, as an indicator of the capacity for agenda-setting affects the attention of Congressional decision-makers.[7]

How are the definitional activities of scientists expressed? Scientific elites play a prominent role in the construction of social issues and the generation of public concern on climate change through publications, briefings, testimonies and hearings. The traditional outlets of scientific research and claims-making activities are publications. "Representing a presumed consensus," summary reports and integrated scientific assessments are, however, "…a more important political tool for the élite than normal publications that practitioners use to build the state-of-the-art (that is technical journal articles)" (Hart and Victor 1993, 668). Summary reports, along with public testimonies and hearings are the major "strategies and tactics of advocacy" employed by scientific entrepreneurs (Rosenberg 1991, 3). It is hypothesized that more reports on climate change increase the level of Congressional attention, all else constant (*Hypothesis 1)*.

IV. Data and Methods

To test the proposition that science is an effective policy entrepreneur and agenda-setter, I employ measures of four concepts: *scientific activity, Congressional attention, partisan context* and *public opinion*.

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[6] Hart and Victor (1993) examine US policy and scientific research related to the greenhouse effect from 1957 to 1974. I look at the period 1975-2005.

[7] The assumption here is that scientific findings are effectively used, i.e. not misused in the definition and formation of climate change policy.

The capacity of scientists to set the agenda of policy-makers is defined as the quantity of publications (reports) on the subject of climate change. The *definitional activity of scientific entrepreneurs* is operationalized as number of National Research Council (NRC) reports published between 1975 and 2005. This approach is justified by the NRC reports' objective to provide "authoritative, highly credible, persuasive, and thoughtful […] conclusions and recommendations" to government agencies (NAS)[8]. As 'the working arm' of the National Academies, the NRC is the first and foremost advisor on science and technology to policy-makers. NRC reports on climate change for the period 1975-2005 were identified from the National Academies Press website using keyword searches (see the appendix for details on data collection and coding). The search yielded a total of 164 reports devoted to the subject of climate change/global warming (Table 1 below).

Institutional attention is defined as the time Congress devotes to deliberation on the subject of climate change. The literature supports the view of Congressional committee hearings, testimonies and briefings as the most direct channel for communication between scientific communities and legislators. Congressional hearings are the best available measure of Congressional attention (Baumgartner and Jones 1994), and "an excellent indicator of what Congress is taking seriously" (Edward and Wood 1999, 331).

This paper uses the number of committee hearings devoted to the subject of climate change as a measure of Congressional attention. Hearings for the period 1975-2000 were obtained from the Agendas Project Hearings Data Set (1947-2000) available from the Policy Agendas Project[9]. Data for the remaining period (2000-2005) were collected from the Lexis-

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[8] The National Academies of Sciences, http://www.nationalacademies.org/nrc/.
[9] These data were obtained from the Center for American Politics and Public Policy at the University of Washing (http://www.policyagendas.org/index.html). The project is headed by Frank R. Baumgartner and Bryan D. Jones.

Nexis Congressional database (details are in the appendix). Using a code system of keyword searches, a sample of 193 hearings was obtained.

Changes in *partisan context* are likely to affect the level of Congressional attention. For instance, it can be expected that hearings on the adverse effects of weather modification will be more likely during Democratic majorities in Congress. On the other hand, attention to the social and economic ramifications of carbon regulation may be associated with the presence of more Republicans in Congress. To account for the variation in partisan context I employ a measure of the mean political ideology in Congress – from the 94^{th} to the109^{th} Congress, 1975-2005. Using the liberal-conservative ideology scores of individual members (DW-Nominate data[10]), I computed the median ideology position for each chamber for each session of Congress. Next, the median scores were standardized, so that each chamber score has a mean of zero and a standard deviation of 1 (z-values). Finally, the mean standardized political ideology for Congress was computed.

As explained in the theory section, legislators are guided by the legitimate interests of the public (Lowi 1979). Conventional measures of what the public 'holds dear' are public opinion polls. To capture *public opinion* on environmental problems (like climate change), I employ Gallup Public Opinion Polls, Most Important Problem Question dataset (1974-2004)[11] available from the Policy Agendas Project website[12]. Public opinion is measured as the annualized proportion of responses that fall within the environmental topic.

Finally, data on control measures, such as House/Senate committee hearing and election year were obtained from the Agendas Project Hearings dataset and Lexis-Nexis database. It is

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[10] DW-Nominate data were obtained from the Voteview website: http://voteview.com/.
[11] Missing values for 2005 Gallup Public Opinion Polls were imputed based on last years' values (2004).
[12] http://www.policyagendas.org/index.html

empirically observed that more hearings are held by House than by Senate committees (Jones and Baumgartner 2005). Since this trend is present in the Policy Agendas Project data, a control measure for House hearings was constructed. Election years have a similar effect on the intensity and level of Congressional attention. Because more hearings are held in non-election years, a dichotomous variable for election year was included. As a result, a dataset was created that included information on congressional session, annual number of hearings, annual number of NRC reports, mean political ideology in Congress, Gallup data on environmental problems, as well as control measures for House hearings and election year (Table 1 below).

"Some questions can be decided, even if not answered"[13]

V. Analysis and Results

The simultaneous interaction between science and policy renders a structural equation model with imposed parameter directions an inappropriate analytical method. The process nature and behavioral characteristics of the science-policy relationship suggest a dynamic, rather than a static-equilibrium analysis. Following Green (2001), I employ a dynamic model as a better methodological approach to the proposed research question. This technique helps uncover the patterns of policy-makers' attention to climate science.

First, it is expected that the overall time-path of observed phenomena (scientific activity and policy attention) affects present levels of Congressional attention. Thus, measures ofthe cumulative volume of both reports and hearings are included. Second, more recent events (e.g.

last year's publications) are likely to have greater impact on current levels of legislative attention. Consequently, I employ measures to capture the preceding year's level of scientific activity and hearings (lagged reports and lagged hearings[14]).

Since the outcome of interest – number of Congressional hearings – is a count variable, a count model is employed in place of ordinary least squares (Kennedy 2003). The negative binomial regression model (NBRM) is preferred to the Poisson[15], because of significant evidence of overdispersion (χ^2=6.72, p<.01). The contagious nature of events further informs this choice (Long 1997). Specifically, increased scientific activity is expected to generate a 'contagious effect', leading to more publications on the same topic in the future (Stone 2002). In short, to capture the relationship between scientific activity and Congressional attention, I employ a count model with a dynamic component, described as:

$$Hearings_t = f\{\sum Reports, Reports_{t-1}, \sum Hearings, Hearings_{t-1}, Public\ Opinion\ on\ Environment_t, Mean\ Political\ Ideology_t, House, Election\ Year\}$$

Table 1 presents summary statistics for all variables used in the regression analysis. Data summaries reveal that there were, on average, six hearings per year during the thirty-year period examined here. The level of scientific activity exhibits a similar magnitude. Specifically, there were roughly five NRC reports on the topic of climate change between 1975 and 2005.

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[13] (Justice Louis Brandeis *in* Schneider and Mesirow 1976, Cover page)
[14] The lagged dependent variable (i.e. lagged hearings) is also used as a way to address serial correlation.
[15] An additional concern is the unrealistically strong assumptions of the Poisson model.

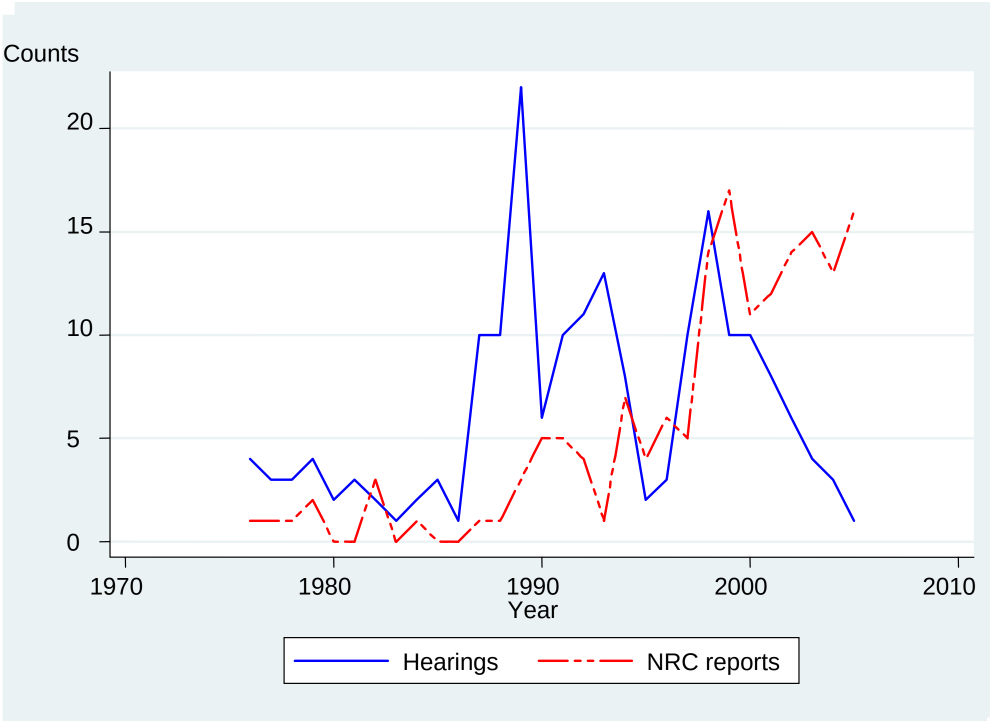
Cumulatively, the average volume of Congressional attention (82.8 hearings) outweighed the total average number of reports (42.6) on climate change nearly twice.

Table 1: Descriptive Statistics (1976-2005, N=30)

Variables	***Mean***	***Std. Dev.***	***Min***	***Max***
Congressional hearings	6.37	5.03	1.00	22.00
Cumulative hearings	82.83	65.49	2.00	192.00
Lagged hearings (t-1)	6.40	5.00	1.00	22.00
NRC reports	5.43	5.67	0.00	17.00
Cumulative reports	42.67	48.19	1.00	163.00
Lagged reports (t-1)	4.93	5.36	0.00	17.00
Mean Political Ideology	0.03	0.81	-0.79	1.81
Public Opinion on Environment	0.01	0.01	0.00	0.04
House	0.90	0.31	0.00	1.00
Election Year	0.50	0.51	0.00	1.00

A time-line comparison of policy-makers' attention and scientific work reveals that the amount of scientific work is not always associated with the same (or corresponding) level of Congressional attention (Figure 1). Overall, between 1975 and 2000 the level of scientific activity was paralleled by an approximately the same amount of Congressional hearings. However, since the year 2000 a divergence between scientific activity and policy attention to climate change can be observed. In particular, the number of hearings has plummeted, while the number of climate-related reports has risen. The reverse relationship occurred in the late 1980s. To illustrate, 22 hearings were held on the topic of climate change in 1989, with only 3 NRC reports out that year and overall of 14 climate-related reports published by that time (1975-89).

Figure 1: Congressional Hearings and NRC Reports on Climate Change (1975-2005)



Results from the regression analysis do not provide sufficient evidence in support of the claim that scientific elites, through publications and claims-making activities, can influence policy-makers' attention to climate change. The NBRM results indicate a strong negative association between scientific activity and the expected level of Congressional attention to climate policy. More NRC reports are likely to reduce policy attention to the problem of climate change (Table 2 below).

This research finds insufficient evidence to support the claim that more scientific activity increases the level of Congressional attention to climate-related issues (Hypothesis 1, $p<.01$). Past deliberations on climate change, as indicated by the cumulative number of hearings, is a significant predictor of Congressional attention to climate change ($p<.05$). Consistent with theoretical expectations, public opinion affects the agenda of Congressional policy-makers, even if marginally significant (Table 2, $p<.10$).

Table 2: Congressional Attention to NRC Reports (1976-2005)
Negative-binomial regression model results (N=30)
Dependent Variable: Hearings

Variable	*NBRM (with lagged reports)*	*NBRM (w/out lagged reports)*
Cumulative Reports	-0.019**	-0.021***
	(0.009)	(-0.008)
Reports(t-1)	-0.019	
	(0.046)	
Cumulative Hearings	0.012**	0.012**
	(0.005)	(0.005)
Hearings(t-1)	0.027	0.025
	(0.029)	(0.029)
Public Opinion on Environment	18.456*	18.292*
	(10.194)	10.254
Mean Political Ideology	0.289	0.278
	(0.186)	(0.185)
Election Year	-0.171	-0.160
	(0.203)	(0.202)
House	1.138**	1.161**
	(0.572)	(0.571)
Constant	0.269	0.250
	(0.557)	(0.556)
Statistics		
LR chi2	25.72	25.56
p	0.00	0.00
Psuedo R2	0.15	0.15

Note: Standard errors in parenthesis; * significant at 10%,
** significant at 5%, *** significant at 1%.

While the regression analysis sheds light on the dependence of Congressional attention on expert knowledge and public opinion, it does not directly imply a causal relationship between scientific activity and policy attention. To explore the latter, I employ a Granger causality test[16],

[16] Also known as Wiener-Granger causality test.

as the most common procedure for predictive causality with time-series data (Gujarati 2003). The test is based on the assumption of temporal antecedence, namely that only "events in the past can cause events to happen today" (Koop in Gujarati 2003, 696). More specifically, changes in Congressional attention should be preceded by a change in the volume of scientific activity (e.g. a new NRC report).

Operationally, the test employs a past value for reports (lagged reports). First, the lagged value was included in the so-called unrestricted regression model (NBRM with lagged value, Table 2). Next, the restricted regression equation excluding the past value for reports was estimated (NBRM without lagged reports). The null hypothesis is that the effect of past reports is zero. Based on the test results, the null hypothesis fails to be rejected at the .10 level (F= .51, df=1, 22, p=.48)[17]. Table 2 indicates that the coefficient associated with lagged reports is not statistically different from zero (b=-.019, p=.684).

Based on the Granger causality test, unidirectional causality from scientific activity to Congressional attention cannot be established. These results shed light on the causal structure between science and policy, as well as the study's key question. They suggest that rather than science, it may be the policy or politics 'stream' that comes first. As indicated in Table 2, the effect of cumulative hearings is statistically significant and different from zero (p<.00).

Figures 2 and 3 below illustrate the impact of scientific work (NRC reports) and past hearings on the expected level of Congressional attention to climate change. As shown on Figure 2 additional scientific work on the subject of climate change is not likely to spur more

[17] The Granger causality test employs an F-test to estimate whether the effect of the lagged value is different from zero (Gujarati 2003:696).

Congressional attention[18]. This finding (along with the results of the Granger causality test) provides evidence contrary to the expectation of Kingdon's model. In fact it can be suggested that policy, not science is the true agenda-setter. According to Figure 3, the overall volume of hearings is likely to generate in the future additional Congressional attention on the same topic (i.e. the probability of zero hearings decreases).

Figure 2: Probability of Zero Hearings for Cumulative NRC Reports

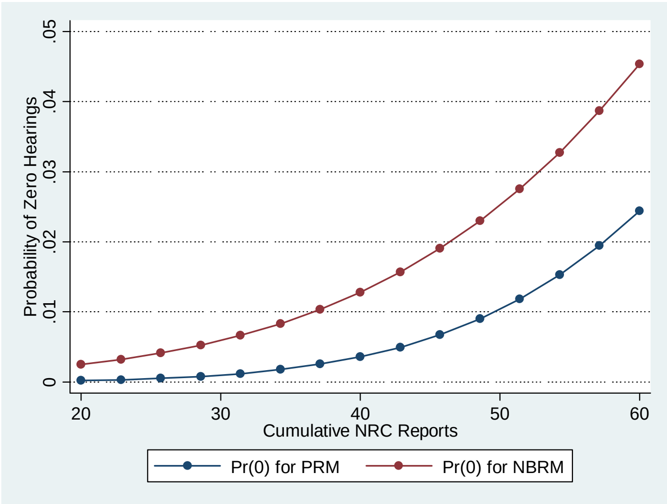
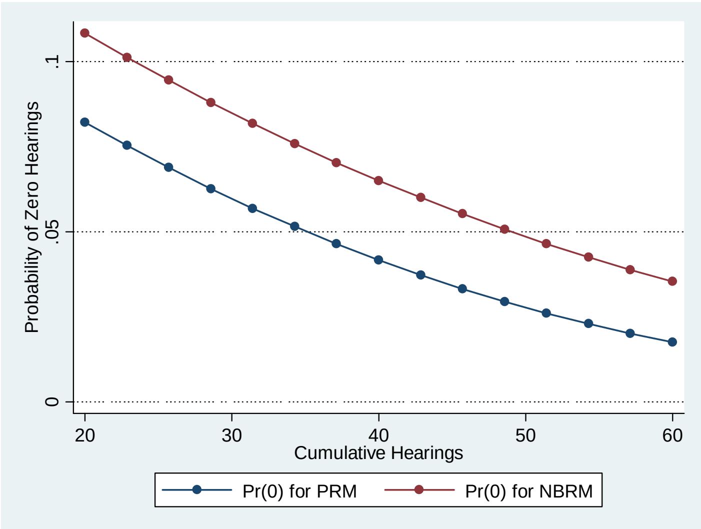


Figure 3: Probability of Zero Hearings for Cumulative Hearings



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[18] These graphs depict the probability of zero counts (no hearings). Interpretations may seem counterintuitive at first

> *"…science and technology have changed, and continue to change, our system of governance, the nature of issues policymakers deal with, the role of government in society, the responsibilities of citizens, and the meaning of such central concepts as liberty, political accountability, and democracy"* (Schmandt and Katz 1986, 40)

VI. Conclusion:

This paper has attempted to elucidate the role and relative influence of science in the policy process. It sought to explain how scientific elites influence public policy in a pluralist democracy using interest mobilization, group theory, and agenda-setting as its theoretical lenses. The central question was the ability of scientists to act as policy entrepreneurs in the policy debate on climate change. Results from the regression estimation and the Granger causality test fail to support this proposition. The empirical analysis finds insufficient evidence to support the claim that scientific elites act in an entrepreneurial fashion. The role of scientists in climate policy remains one of simple inventors, as opposed to the more powerful one of policy entrepreneurs and agenda-setters.

While limited in its validity, this finding aligns with previous work, according to which the influence of science in the policy process diffuses once a problem is identified and conveyed to policy-makers (Hart and Victor 1993, Paterson 1996). Although both problem recognition and definition shape policy outcomes, definition clearly affords greater opportunity to influence the policy agenda (Kingdon 1995, 201). That is where greater scientific involvement is desired, since issue definition is crucial for interest mobilization and policy outcomes.

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glance; however they are consistent with the result of the NBRM analysis.

Changes in Congressional attention to climate change are likely to follow from the policy and/or politics stream, rather than from scientific activity and publications. Consistent with theoretical expectations public opinion does matter to policy-makers. This study illuminates the balance between modern scientific enterprise and democratic controls over government. Plainly, "the expert could be said to propose and the mass [to] dispose" (Holden 1993, 197).

This study is not without limitations. The measures for scientific activity and policy attention were constructed using keyword searches, which makes them sensitive to the terms used. Next to measurement issues, there are concerns with causal inference due to construct validity problems. Publications are only one outlet for scientific activity. The potential effect of other entrepreneurial activities used by scientific elites remains unobserved and unaccounted for by this study. Finally, partisanship, gender, and institutional affiliation of both committee chairs and expert witnesses are important background characteristics that remain outside the scope of this analysis.

Arguments that complicate the quantitative approach of the study stem from the very nature of science as "socio-politically constructed and constructing" force (Cozzens and Woodhouse 1995, 553). A potentially fruitful analytical path for the future is to explore the cohesiveness of scientific claims through content analysis of hearings transcripts. This may help better understand how science and policy co-construct each other to design climate policies over time, as well as to shape our systems of governance.

Appendix:

Data Collection and Coding

Data collection employed search engines available at the NAP website [19], and inter-library research[20]. A code system of keyword searches was constructed, which included the following keywords: climate change/ climate*, (global) warming, greenhouse* (gases/effect), climate vulnerability/ variability/adaptation/modification, carbon dioxide/cycle, climatology, global climate system, and weather*. More specifically, the data collection process included the following steps and selection criteria: i) read report title; ii) read description and/or summary of the report to fully assess its content in terms of scientific claims-making activity on climate change; iii) conduct a machine-read text search for the context and frequency of keywords in the report; iv) if ambiguous, read each chapter of the report.

Hearings on the subject of climate change/global warming were identified using the Agendas Project Hearings dataset (1975-2000) and the CIS index on Lexis-Nexis (2001- 2005). A code system of keyword searches was employed for the Lexis-Nexis database (same as above). For the Agendas Project data a keyword search was conducted for the following two subtopics: (705) Air pollution, Global Warming, and Noise Pollution and (1708) Weather Forecasting and Related Issues, NOAA, Oceanography.

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[19] The Discovery Engine of the NAP (http://www.nap.edu) searches more than 550,000 book pages from more than 3,500 formal publications produced by The National Academy of Sciences, The National Academy of Engineering, The Institute of Medicine, and The National Research Council, plus more than 100,000 web documents from the National Academies: current projects, testimony, press releases, news documents, etc.

[20] Most reports were available electronically, although a number of older publications were accessible in print only.

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