The Problem of Representing Discounted Benefits in U.S. Climate Change Policy Deliberations

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Abstract

This paper draws upon social studies of science literature to discuss the controversy over economic discounting as it relates to near term costs and long term benefits of global climate change (GCC) policies. Previous research has shown that science-based controversies often become more polarized and undisciplined when they are relevant to adversarial policy deliberations. Experts are often tapped to defend opposing vested interests, seemingly enhancing the degree of scientific disagreement. To counter polarization and to defend their objectivity, experts may perform "boundary-work" by rhetorically or organizationally differentiating scientific facts from more normative political statements. This paper reviews the controversy over economic discounting as it applies to GCC and then empirically examines its representation (or lack thereof) in U.S. policy deliberations on global climate change (using congressional hearings as data). Instead of further polarization or the construction of boundaries, we find that economic experts either ignore the controversy in their testimony or use hybrid representations that combine the economics problem with ethical, lay, or other beliefs and values. Through the use of analogies such as purchasing insurance and references to future generations as grandchildren, near term costs without equivalent future discounted benefits seem more acceptable. These hybrid constructions would seem to provide economists with an avenue for presenting the type of policy-relevant expertise that they prefer while avoiding a more polarizing and vexing economic problem. However, the paper provides some evidence that these stabilized hybrids become objects that are destabilized and reconstructed by other economists. The paper also comments on the potential general effectiveness of these hybrid constructions for policy deliberations on other long-term environmental consequences.

Introduction

Economic discounting is a standard procedure in cost/benefit analyses that hold a significant time dimension. The justification for discounting lies in a present time orientation and an expectation of higher future wealth. A higher value is placed on a unit of consumption today than the same future unit because of personal impatience and the reduced marginal utility of future consumption with increased wealth. When considering present costs and future benefits, economists discount the benefits by a rate that reflects the higher value of current consumption.

Discount rates in cost/benefit analysis often are chosen with the use of empirical market information. One typical benchmark is the current rate of interest for the time difference in question. For longer time periods, the average stock market rate of return might be used. These market rates are assumed to reflect the potential for future economic growth and the preference for present time consumption.

Cost/benefit analysis of U.S. environmental policy is increasingly the norm. Government demands that environmental objectives be economically justifiable and reached in economically efficient ways. Economists have met this objective by calculating costs, intended environmental benefits, and residual costs and benefits of policies. Where significant time differences exist between costs and environmental benefits, economists typically discount the benefits to account for the effects of time preference and future increased wealth.

Cost/benefit analysis of GCC policies, however, is more complex for several reasons. First, the time difference between costs and benefits far exceed the typical range in most

economic analyses. Proposed GCC policies generally include near-term costs with most targeted benefits (reduction in damage due to climatic change) received in the distant future – 100–400 years is the time scale most often mentioned. If one uses a standard long-term interest rate (e.g., 30 year mortgage rate or average long-term rate of return of the stock market), or even a slightly lower rate, long-term future benefits do not justify near-term costs with the exception worst case scenarios. Yet most economists working on this problem prefer not to preemptively dismiss a GCC policy with near-term costs due perhaps to some combination of intellectual and political reasons.

Second, economists face major uncertainties over costs of GCC policies, costs of GCC damage, long-term future economic growth rates, likelihood of major technological breakthroughs, and future interest rates. Each variable could significantly affect the appropriate discount rate.

Third, most cases for discounting involve either individual costs and benefits or social costs and benefits for a very similar population. For example, the decision to reduce sulfur dioxide and nitrogen oxide emissions yielded benefits in the form of reductions in acid deposition for the same generation and often in the same nation. GCC is not one of these cases. The short-term costs of a GCC policy will be paid by current generations in, most likely, the wealthier nations that initiate the action. A majority of the direct benefits, however, will be received by future generations who live in non-western nations. This means that the pure rate of time preference based on personal consumption/saving habits is less relevant and social discounting is more complex because of cross-generational and cross-national differences between cost bearers and benefit recipients.

These complexities have generated a scientific controversy in the economics community on how to discount GCC policies with several positions defended. There seem to be three general modes of reasoning behind the different positions[i]: 1) Discount as usual because future generations are inevitably richer so benefits are marginally much lower. Uncertainty in future growth rates and environmental destruction can be estimated. 2) GCC is an instance of market failure because future generations are unable to bargain for themselves at the present. The discount rate needs to be artificially set (typically quite low) to account for this failure. 3) The discount rate is less significant in cost/benefit analysis because of the ethical and equity dimensions of the problem. That is, costs of GCC policies must be considered in the context of the sort of natural environment that we owe future generations and global inequity between those who have received the benefits of greenhouse gas emissions and those paying the costs of unimpeded global warming. With this line of thinking, decisions about discounting only become relevant once the ethical and equity problem is addressed.

This controversy in the economics community has been present at least since the mid to late 1990s, and has yet been resolved despite an extensive literature on the subject. The controversy was most recently highlighted in the reaction to the Stern Report in the UK, which centered on the committee's choice of a low discount rate. The controversy itself is an interesting story. However, as it has ensued, economists also have been used as experts in policy deliberations on GCC. These dual occurrences generate the main research problem in this paper: how has the controversy over discounting been represented by economists and other policy actors in GCC policy deliberations?

My analysis to this point has focused on U.S. congressional hearings. As described

below, two different strategies have been used. Economists have tried to ignore the controversy by focusing attention on costs, or ways of reducing costs, of a GCC policy and imply benefits without specific calculations. Or they have tried to suspend the controversy with the generation and use of hybrid frames that fuse ethical, lay, and political reasoning and discourse with economic knowledge. I suggest that these approaches provide alternative, potentially effective (and potentially ineffective) means for managing science-based controversies that are policy relevant. However, these new hybrid forms also can be moving targets open to reformulation and use for alternative purposes.

The first section of the paper reviews STS literature on scientific controversies. The second section describes several positions held by economists in the GCC discounting controversy. The third section analyzes how this controversy has been represented in U.S. congressional hearings. The last section discusses the implications of these representations.

Scientific Controversy

Scientific controversies are an important topic for social studies of science. They make an excellent research site for watching science in action and their outcome is often significant for technical or other social problems.[ii] From a social studies of knowledge (SSK) perspective, scientific controversies often reveal social processes like negotiations, localized practices, practical reasoning, social interests, power influences and other important parts of knowledge building not ordinarily visible to outsiders (e.g., Collins 1974, 1975; Collins and Pinch 1993; Gilbert & Mulkay 1984; Knorr-Cetina 1999; Latour 1988; MacKenzie 1981; Pickering 1984, 1992; Pinch 1986). This research tends to focus on the social and natural outcomes of scientific

controversy, conceptualizing them as dually constructed. Latour (1987), for example, noted how nature is the *outcome* of the closure of controversy rather than its cause. In more current understanding and terminology, "nature" and "society" may be co-constructed through the generation, management, and resolution of scientific controversy.

When scientific controversies mirror or are directly relevant to broader social problems, they may appear quite messy to non-scientists who hold assumptions about science as a definitive and asocial producer of truth. Scientific expertise may be drawn upon to resolve problems, but it often ends up further polarizing disparate positions when no definitive scientific consensus exists (e.g., Mazur 1981, Nelkin 1984). Quite simply, each set of interests choose the experts and expertise that best advance their position, with an outcome looking like a neutralized tug-of-war between equally committed sides.

Several key findings from research on societal-relevant scientific controversies can be highlighted. Scientific controversies can be understood as a process with a history that is structured in three overlapping phases: origin, crystallization, and termination (Brante & Hallberg 1991). They are generated when relatively high-profile claims compete with each other for a definitive definition of truth. Crystallization occurs as the different claims become more entrenched in science with more or less organized groups of scientists on different sides (Brante & Hallberg 1991)). In the case of public/political controversies, interest groups outside of science may join with scientists to help crystallize the debate. Brante and Hallberg's third phase of termination involves the closure or, in some cases, abandonment of the controversy. The controversy is either resolved through one or more of several different closure mechanisms or it is abandoned as scientists lose interest and move on to other problems.

This snapshot of the phases of scientific controversies may be useful for generating research questions, but tells us little about the complexities of the controversy itself. Scientific controversies are not easy to resolve through scientific research because of the experimenter's regress problem that Collins (1985) discussed. Because of local cultural contingencies in scientific work, scientists cannot be certain that an experiment is an exact replication of what transpired in another laboratory. Different results, where the "facts" are unknown, can be explained either as an indication of what nature really is *or* as byproducts of the conduct of the experiment. Despite this dilemma, controversies often do reach closure with one set of claims accepted in the scientific community as definitive scientific knowledge. Explanations for this achievement range from rhetorical force, influence of power arrangements, luck, or death of an adversary (e.g, Collins and Pinch 1993). Once closure is achieved, the negotiated and contingent features of the production process seem to disappear. A stable conception of nature comes to appear as the ultimate arbiter of truth (Latour 1987) and social order is accomplished. Several specific features of scientific controversies and closure are reviewed below.

Discourse: Discursive features of scientific controversies have been emphasized in the work of Ashmore (1989), Gilbert and Mulkay (1984), and Woolgar (1988) among others. They argue that discourse takes priority in understanding the development and resolution of controversy. Gilbert and Mulkay's (1984) distinction between contingent and empiricist repertoires in scientists' talk, for example, is relevant to understanding how controversy is maintained and eventually closed. Contingent repertoires of the natural world leave open the possibility that it could be otherwise under different social or personal characteristics, helping sustain controversy. An empiricist repertoire tends to close off alternative accounts of nature

because it appears as if nature itself is doing the speaking. This repertoire can be effectively used to close off controversy. Both repertoires are used in patterned ways across scientific contexts: informal settings such as discussion in the lab and formal settings such as a claim at a professional meeting (Gilbert and Mulkay 1984).

Co-construction: Scientific controversies may not solely be about the state of nature, but also the state of society (Latour 1987, 1988; Callon 1986a, 1986b). They involve battles over competing claims to scientific truth, but also battles over social, political, economic, and cultural order (Jasanoff 1996, Wynne 1996). Research on co-construction has challenged the actual concept of scientific controversy as it has been typically defined. Jasanoff (1996) argues that a shift in focus to a reflexive examination of co-production processes in social studies of science might actually replace studies of politically relevant scientific controversies with their emphasis on different sides and winning and losing. As an example of this move, Shackley and Wynne (1996) show how claims about scientific uncertainty served both to replace indeterminacy on future rates of global warming and as a boundary-ordering device between advisory scientists and policy makers on GCC. According to their analysis, representations of scientific uncertainty involved a discourse shared by and used to bring social order within and between these two communities as scientific knowledge was co-constructed.

Hybrid Knowledge: As scientific controversies unfold, we sometimes see the development of hybrid knowledge and discourses that may seamlessly resolve or limit the intensity of controversy. In a case examined by Epstein (1996), AIDS social movement members helped effect change in the conduct of AIDS medical research, yielding both improved science and movement objectives. Special expertise held by movement members was combined

with medical researchers' scientific practice into a hybrid methodology that transformed research. Wynne's (1996) study of the Cumbrian sheep farmers is a similar case, with the exception that scientific experts were less receptive to farmers' lay knowledge. The ozone depletion case of the 1980s also is illustrative when a hybrid discourse centered around the precautionary principle helped move the political process along even though the scientific community was still debating causes of the ozone hole and long-term impacts of ozone decline (Benedict 1991, Litfin 1994).

Boundary Work: An artificial closure may be drawn by scientists where controversy is at least temporarily downplayed for purposes of imposing scientific order and authority on the public problem. Boundary work may be used in an attempt to disentangle scientific information from the value-laden and often messy business of providing policy advice (Gieryn 1999, Jasanoff 1990). Boundary work can be performed rhetorically (Gieryn 1983), organizationally (Guston 2000), or there may be attempts to impose it through the use of a science court (e.g., Mazur 1981).

Maintaining cognitive authority in controversial arenas is an important outcome of boundary work (Gieryn 1983, 1999). Scientific controversies may emerge as a consequence of vague boundaries between science and other, possibly competitive, intellectual activities. Scientists may engage in boundary work as they bring their expertise to the policy arena where science is clearly differentiated from politics or some other activity. Jasanoff (1990) has shown, for instance, how scientific advisors within different U.S. federal agencies differentiate between risk assessment (the domain of science) and risk management (realm of politics) when expertise is given on such issues as the safety of food and drugs, occupational safety standards, or

acceptable pollution levels. Boundary work may help protect the authority of scientific expertise and methodology from possible erosion as controversial science is brought to bear on public policy. Boundary work also may be institutionally based as Guston (2000) shows in his analysis of science policy since WWII. In the 1980s, "boundary organizations" have emerged (e.g., National Institute of Health) to help manage relations between science and politics in the development of science policy (Guston 2000).

Boundary organizations may play dual roles in mediating between scientific expertise and its implications for policy. On the one hand, they may serve to clarify and maintain separation between science and politics. A boundary organization can serve as a conduit for sorting through scientific expertise and disentangling controversy and apply the results to policy questions. Through these efforts, science also may retain its perception of purity from political entanglements and its cognitive authority as a provider of truthful, unbiased knowledge.

Drawing upon Star and Griesemer's (1989) notion of boundary objects, on the other hand, boundary organizations might serve to create hybrid concoctions of science and policy that intentionally cannot be disentangled into separate categories of science and politics. Scientific controversy may be managed such that more certain, hybrid knowledges emerge that are directly applicable to policy deliberations. Shackley and Wynne (1996), for example, have shown how parameters around an estimated range for future global warming were used as a boundary-object within scientific and political communities to maintain relations of social order and control both within and between them, circumventing broader scientific indeterminacy and controversy.

It is this notion of hybrid knowledge, but without boundary organizations, that this paper is intended to illustrate. It examines primarily the construction of hybrid knowledge which

represents or circumvents a scientific controversy so that new knowledge products are produced consisting of combinations of scientific and non-scientific elements that cannot really be separated into component parts. The idea of hybrid knowledge products emerged from work by Latour, Callon, Law, and others on the construction of heterogeneous networks. However, in this economic discounting case the new knowledge products do not necessarily take on a scientific status, nor do they directly take on a particular political status either. They also are different from boundary objects in a couple of senses. First, they are not intended to stand between science and politics as a way of socially and cognitively ordering those two domains. Second, their transportability may be limited. They don't, for instance, resolve the scientific controversy, though there is some evidence that they are being used in science as well as policy deliberations. These hybrid knowledge products must be interpreted as emergent within the localized policy setting.[iii] They also can be functional in the sense that they shift attention away from a scientific controversy so that policy deliberations can proceed in an orderly manner while still making use of potentially controversial scientific expertise.

The next section reviews the scientific controversy over discounting GCC policy. The paper then focuses on its representation, and avoidance, in congressional hearings.

The Controversy over Discounting Global Climate Change Policies

In general, economic discounting is uncontroversial. Economists assume that people hold a current time preference due to impatience, inflation, and expectation of future greater wealth. A particular unit of consumption will be less beneficial in the future, so its future value must be discounted. Normally, economists use interest rates or average stock market rate of

return as a proxy to determine the discount rate because they make a good general societal measure of time preferences. These rates vary historically, across time frames, and across societies.

Many economists consider discounting to be relevant to decisions about GCC policy. Costs will begin to accrue as soon as a policy is enacted, but most benefits are not expected until the distant future. The value of these future benefits would need to be discounted and weighed against consumption precluded by current costs. However, as previously noted, climate change poses a dilemma. For example, if we use a typical 5% discount rate, $1 million in damage 200 years from now is worth only about $58 today (Cline 1999). Or to place it in different terms, $1 million in expenditures on green house gas mitigation today will yield $58 of benefit to people 200 years from now. For many economists, a standard discount rate generates unacceptable results for academic, political, environmental, and ethical reasons. It is uncomfortable to scientifically justify a course of limited action or non-action when addressing a problem with potentially catastrophic effects on future generations. This uneasiness has helped generate a professional controversy over discounting costs of GCC policy and the political significance of discounting itself[iv].

Several positions have been staked out. These were identified through personal interviews with climate change economists conducted between 2000-2002, professional literature generated through a search on *EconLit*, review of published papers presented at a workshop organized by Resources for the Future on discounting GCC policy (Portney and Weyant, 1999), and responses in the professional literature to the Stern Report.

General orientations toward discounting may be prescriptive or descriptive. Prescriptive

approaches determine discount rates from ethical principles such as those based on equity and fairness. They are generally lower. Descriptive approaches involve choosing a discount rate based on observations of the rate(s) of return to capital invested in a variety of alternative assets. Economists, by and large, use a descriptive approach, but often alter basic assumptions and methods of calculation because of the time horizon, intergenerational aspect, and uncertainty of the climate change problem. It is these alterations that lead to controversy.

1. Keep discounting as if people lived forever: One simple and widespread practice is to discount at present rates, as if people lived forever. The basic question for proponents of this position is whether the underlying trend of the real interest rate will remain the same. As Martin Weitzman puts it: will future generations continually be able to use new human ingenuity to develop further productive capacity at similar rates as the present (Weitzman 1999)? Weitzman and others argue that there is no reason *in principle* why we would think that deep future productivity rates will be lower than today. Thus, we should discount at current rates unless other factors are relevant.

Proponents of this approach distinguish between equity and efficiency in determining discount rates. They feel that equity and efficiency can be separated if the benefits of global climate change mitigation, as measured by the market value of damages avoided, can be determined directly or be described in terms of "willingness-to-pay" (Manne 1999). An efficient means for achieving greenhouse gas mitigation can first be identified and then one can separately deal with the problem of making the policy globally equitable. For instance, efficiency considerations might lead to a cap and trade system or a carbon tax. Once one of these mechanisms becomes policy, equity questions would revolve around the original distribution of

pollution permits (e.g., auction, grandfathering based on current polluting activity) among economic entities within and across nations or whether carbon taxes should be levied upstream or downstream or vary for necessary versus luxury energy use. Equity considerations would also be relevant to intergenerational considerations. Is it more equitable to clean as one goes, or to expect some clean-up to be conducted by future, wealthier societies?

The separation of equity from efficiency on intergenerational discounting has received some modeling support from the work of Alan Manne and others at Stanford University. In comparing the results of infinite-lived agent (ILA) versus overlapping generations (OLG) models, Manne (1999) finds no significant differences. Consequentially, he advocates use of the simpler ILA model even though its basic assumption is obviously false. He notes that there are existing appropriate markets for realizing distant-future benefits of current greenhouse gas mitigation. For example, an individual may purchase land, incur the cost of planting seedlings, and benefit from their growth in value even though timber will never be harvested in his/her lifetime. Land value would accrue by a measurable rate even though the substance that creates the value may not be used for 75-100 years or longer.

A potentially significant problem with this approach is the uncertainty of deep future (or sometimes near future) costs and benefits. How can this uncertainty be effectively managed in the determination of discount rates? Newell and Pizer (2001, 2003) from Resources for the Future and Weitzman (1998) argue that uncertainty and the "persistence" (or autocorrelation) of interest rates lead to lower valuations of the discount rate the further one goes into the future. Using historical data on interest rates over the past 200 years, they find evidence to support two models -- a "random walk model" and a "reversion to the mean" model,[v] but argue that the

random walk model is a better fit. They find a high level of autocorrelation in interest rates over the past 200 years. The random walk model best captures this autocorrelation because interest rates tended to move randomly from the point at which they were the previous year, rather than following a tendency to revert to some prior mean. In other words, a 20 year period of interest rates lower than a mean is more likely to be followed by similarly low rates than rates equally distant on the other side of a prior mean.

Extending this analysis to the future, they argue that since discount rates are uncertain, but more likely to follow a random walk model, contemporary valuations of future discount rates are smaller than if one used current interest rates. The reversion to the mean model would also yield a lower discount rate, but not as low as the random walk model. Using the random walk model and incorporating uncertainty, Newell and Pizer (2001, 2003) generate a "certainty-equivalent rate" that drops from 4% to 2% after the next 100 years, 1% after 200 years and .5% after 300 years (compared to a mean-reverting model of 3.8%, 2%, and 1% respectively). When they apply this analysis to climate change mitigation, they find that the expected marginal benefits could be understated by a factor of two in analyses that ignore uncertainty in the discount rate, making some climate change policies more economically justifiable.

In a similar vein, Howarth (2003) draws parallels between investing in GCC policy and risk-free financial assets. There is always a risk premium that is applied to investments in the stock market or some other entity, yielding a higher rate. Howarth feels that investments in climate stabilization policies reduce forward uncertainties and risks in other investments, as well as being a risk-free investment itself. He argues that this risk aversion yields a much lower discount rate that is comparable to annual rates of return of relatively risk-free financial assets

such as corporate bonds and treasury bills -- in the range of 0 - 2.6% per year.

Another type of infinite lived agent analysis recognizes that discount rates for individuals tend to follow a hyperbolic path. The discount rate in the near term is larger than in their distant future (Cropper and Laibson 1999). For example, we expect a higher rate of return for saving for retirement earlier in our lives than we would find acceptable much later in our lives when we are likely to be wealthier. Applying this point to GCC policy leads one to discount the costs of greenhouse gas mitigation highly over the short term but much lower over the long term. This outcome is consistent with results that incorporate uncertainty, but reflects a different path of reasoning.

2. Tweaking the Discount Rate to Account for Intergenerational Effects: Some economists argue that intergenerational discounting is a special case that requires adjustments to common discounting practices. More benefits of GCC policy will be received by different generations than those that bear most of the costs. A cost/benefit analysis used to evaluate whether a policy is "good" or "bad" must evaluate separately the losses to the losers and the gains to the winner rather than simply aggregating them (Bradford 1999). One would need to calculate what people in the future would pay to avoid climate change damage (to determine benefits) and weigh that against the costs of a GCC policy to the present generation. Of course, politically one must then deal with the problem of gains and losses by different generations. Bradford (1999) suggests that an emissions policy may be more palatable to the present generation by running higher budget deficits to offset the costs. These deficits would be passed on to future, presumably wealthier, generations which receive the policy benefits.

Another way of tweaking the discount rate is through use of a "social rate of time preference" after a period of time so that future generations are not severely biased. The calculation of this discount rate would set the rate of pure time preference (personal impatience) to zero and incorporate a discounting "break" after each 30 years to represent generational breaks (Cline 1999; see also Philibert 1999 for a defense of declining discount rates). These breaks also demarcate a time horizon that actual financial markets reach (e.g., 30-year U.S. home mortgages). This mode of discounting is envisioned as a compromise between the descriptive and prescriptive schools. The basic idea is that one discounts a unit of consumption at a rate of say 5% (from a descriptive approach) over the first 30 years and then discount it at say 1.5% (prescriptive school) thereafter. The 1.5% is calculated by multiplying the elasticity of marginal utility by the growth rate of per capita income (Cline 1999). However, in the spirit of compromise, the consumption unit in year 31 would be valued at a level consistent with the 1.5% discount rate starting from year 1. This resulting discontinuity (between year 30 and 31) would mean that the intergenerational value of the unit would not be penalized by the first 30 years of discounting.

3. Discount as if Costs are a Foreign Aid Package: A novel perspective on discounting comes from the work of Nobel Prize winner Thomas Schelling (1995, 1999). He argues against the use of a time preference of the usual sort because the cost bearers and benefit receivers are different – both intergenerationally and spatially. Nations bearing most of the cost for GCC policy are likely to be developed countries while nations that will eventually receive most of the benefits are currently less developed. Therefore, Schelling argues that we must economically

conceptualize GCC policies as a foreign aid package. Discounting would be focused on the benefits received in less-developed countries, determined by discounting the value of future damage avoided back to its present value. The result could then be weighed against the benefits received through equal expenditures on foreign aid packages to determine the efficiency of the policy (Schelling 1999). For Schelling, approaches that account for intergenerational discounting alone make the mistake of assuming that recipients live in the same nations (and will inherit their present level of resources) as those paying the costs. Since this is not the case, we must discount for the appropriate parts of the world.

4. Discount Against the Ultimate Variable of Interest – Temperature:

William Nordhaus (1994) argues that most proposed cost/benefit-based policies mistakenly focus on the wrong objective. Any ad hoc manipulation of the discount rate to economically justify a course of action, in his view, is a poor substitute for policies that focus on the ultimate objective – lowering global temperature increases. Thus, he proposes setting long-term objectives in relation to acceptable temperature increases, as opposed to targeting a variable like GHG emissions or concentrations or adjusting discount rates. Nordhaus models some of these potential policies with his RICE model and comes to the conclusion that a policy based upon lowering global temperature increases (discounted accordingly) is the most cost efficient. Nordhaus has been most critical of economists' efforts to adjust the discount rate. Results of his model lead him to recommend only minimal, low-cost efforts in the short run to scale back greenhouse gas emissions.

5. Discount Rate may be Zero or Negative: Work by other economists (e.g., Dasgupta, Mäler, and Barrett 1999) suggests that under certain conditions, a long term discount rate may be zero or even negative. Dasgupta et al. (1999) argues that in the case of a polluting by-product with a potential for high risk consequences, one should not rely on risk-free market rates of return of capital investment to compare against a mitigation policy. The potential for high risk events in the distant future may yield a discount rate of zero or even a negative number. To provide empirical support, Dasgupta et al. (1999) remind other economists that the practice of assuming significant continual economic growth makes sense, historically speaking, only over the past 200 years. Over the past 1000 years, the yearly rate of growth is near zero. For a distant future problem like climate change with potential high risk events, they argue that it is inappropriate to assume present growth rates.

These make up some of the major positions in the controversy over discounting climate change policy in the economics community. What is its relevance to actual GCC policy deliberations? Some economists argue that discounting is not relevant because of our inability to accurately quantify in economic terms the sorts of environmental damage that climate change might bring (suggested in several personal interviews). However, to the extent that discounting *is* deemed relevant, policies are sometimes economically judged based upon the chosen discount rate. For example, the recent Stern Review (Stern et al., 2006) advocates immediate action to stem significant economic consequences, even in the medium term. This review has generated much political attention both positive and negative in the U.S., UK, and Europe. The review has been subjected to critique by economists, who have focused most extensively on the authors'

choice of a discount rate (e.g., Nordhaus 2007, Tol and Yohe 2006, Weitzman 2007).

The question I turn to now is how the discounting controversy has played out in policy deliberations. Economic expertise has been an important fixture in U.S. policy deliberations on climate change. Experts have been used to inform the policy process, legitimate political positions, and to critique others' positions. My empirical focus is on U.S. congressional hearings, not necessarily because they are the most important site, but because they are easily accessible, representative of expertise provided elsewhere, and consequential for scientists' cognitive authority. Over time, they also impact U.S. environmental policy.

Science controversies create a potential dilemma for scientists when they are policy relevant. Do scientists ignore the controversy or present one side, which would leave politicians more certain about what scientists have to say? Or do scientists provide a balanced view of the controversy, but perhaps leave politicians with the perception that science is uncertain? Or are there other strategies?

Discounting in U.S. Congressional Hearings

Analysis has been conducted on U.S. congressional hearings on GCC involving economists or closely related professionals as expert witnesses from 1990 to 2007. The discounting controversy was of low salience for much of this period of time. The word discounting was rarely used and economists often skirted the issue. A notable exception is more recent hearings – especially post Stern Review – where the question of discounting took center stage. Throughout this period, however, testimony and discussion occurred on topics that seemed to mirror or closely relate to the discounting problem. In this discussion, much of the

technical economic language was replaced by more normative, principle-based language. A particular image of the distant future was constructed. A wealthy and unrelated future population found in professional discounting literature was replaced by a future population consisting of our children and grandchildren. Also, the sorts of choices that politicians faced were framed less in straightforward cost/benefit language, but in the more general language of making decisions about purchasing insurance against risk. Topics central to the discounting controversy were framed instead in more normative and pragmatic terms.

1. Purchasing Insurance: The "costs" of GCC policies in professional economics literature were often repositioned as an "insurance policy" in political deliberations. A GCC policy, it was said, would purchase insurance against potential future, costly environmental catastrophes. House Representative Roemer set forth the insurance argument in a 1997 hearing:

> Scientific uncertainty does not mean that we cannot act. Faced with real but uncertain risks, we should do for the Earth just what we are doing for ourselves: Consider taking out an insurance policy by reducing CO_2 emissions. And, just as with any insurance purchase, a wise buyer first needs to ask the key question: How much will this insurance policy cost? (Roemer 1997, 98)

Similarly, Mario Molina described insurance as action against uncertainty in a 2005 hearing. Given economic and environmental uncertainty, he claimed, a good insurance policy is the best course of action.

> While there is a growing scientific consensus around the science of climate change, there is, of course, much that we do not fully understand about the timing, geographic distribution, and the severity of the changes in climate, and the economic, environmental and social impacts of these changes that will result if greenhouse gases continue to increase. However, not knowing with certainty how the climate system would respond should not be an excuse for inaction.
>
> Policymakers frequently, in the position of making decisions, they do that in the face of uncertainties. Usually, the presence of uncertainty means that we build extra insurance to protect against the risk that the consequences may be worse than expected. It would be better, of course, if we knew exactly where the perfect balance between costs,

> risks and benefits lies, but the fact is that we never have that luxury.
>
> Nevertheless, policymakers and the individuals both must manage public and personal risks all the time. And we do. Most people buy car insurance even though they do not know with any degree of certainty what their individual risk of being in a car accident might be, just as most doctors would advise an individual with a history of heart trouble to choose low-fat foods and exercise despite the many complex and usually unknowable factors that go into determining any individual person's risk of having a heart attack. (Molina 2005, 31)

If this insurance policy is purchased soon, the premiums will be low, as Dale Landgren of the Wisconsin Electric Power Company suggested in his defense of a need for companies to receive emissions credit for early action.

> We do not believe that support for this concept binds us or binds you as Senators to support the Kyoto Protocol or any other greenhouse gas action. We view a credit for early action program simply as an insurance policy in the event that greenhouse gas reductions are required. Congress should view credit for early action in the same way as an insurance policy, where there is zero cost for the premium. (Landgren 1999, 16)

More recent hearings in response to the Stern Review do tend to include discussions of the controversial choice of a discount rate and allude to the broader economic controversy on this issue. However, economists will occasionally direct politicians away from the controversy, leave it to the professional economists to sort out, while focusing their gaze on the notion of purchasing insurance. As Stern Review critic Gary Yohe put it:

> So with all of that controversy, I would respectfully ask that the members of the Senate, specifically, and the members of the policy-making community in Washington, more generally, not to fall into the trap of focusing all of our attention on the controversies that surround the specific estimates, because you could easily miss the most important messages of the Review. I would urge you to let the economics profession continue to work the problems that we have identified, while you work on the near-term policy in recognition of the important insights of the Stern Review. Focus on the risks of climate change that it identifies. Understand the efficiency grounds for buying insurance against the economic consequences of climate change and also the economic consequences of rapidly ramped-up climate policy in the future that would be required if nothing is done now. (Yohe 2007)

This insurance metaphor became a well-established mode of describing GCC policies in the policy arena, but it was also used in the economics community as well. Economists and others seemed to perceive that the term "insurance" is both an accurate description of the choices that we face and frames the costs of GCC policy into something more palatable to the U.S. public.

In the past few years, some economists have expanded use of the metaphor to include protection against the potential economic catastrophe that a GCC policy might create. They emphasize that it is important to support the GCC policy that would provide the most insurance against significantly negative economic consequences. For example, this includes discussion of a "safety valve" mechanism which would allow regulators to increase the number of CO2 permits if the market price rose to a certain level. This safety valve is described as "insurance" against high near future costs. As economist Richard Morgenstern from Resources for the Future described it in a 2005 hearing:

> Let me now turn to a further discussion of the safety valve. As has been noted by others, it is in effect a type of insurance designed to protect the economy against unexpected price increases caused by weather, stronger than predicted economic growth, technology failures, or other factors. (Morgenstern 2005, 103)

In sum, the insurance policy metaphor re-situated the cost/benefit equation into two different interpretive frameworks. On the one hand, it rhetorically justified a GCC policy where costs might ultimately outweigh benefits. If all of our economic decisions are based solely on rational cost/benefit analysis, we would rarely purchase insurance since average costs outweigh average potential benefits[vi]. Nevertheless, as a practical matter we do purchase insurance to give us peace of mind against potentially major economic risks. We may purchase insurance because it is legally required or as a routine matter without giving it much thought. Describing GCC

policy as an insurance policy potentially reduces or eliminates the requirement that expected benefits exceed costs. Straightforward cost/benefit analysis and discounting become in a sense largely irrelevant at a rhetorical level and the controversy can be avoided as a topic of conversation. On the other hand, once the insurance metaphor was applied to *economic* risk, the discounting controversy became directly relevant again. It would then be necessary to calculate the future economic risks and discount them appropriately.

What this example demonstrates, in my view, is how a hybrid construction that combined economic reasoning, a desire for a GCC policy, and normal layperson activity (buying insurance) was used to effectively circumvent the potential representational problems associated with a scientific controversy. However, once constructed, this new hybrid itself was reconstructed by others to mean something different and used to support the opposite conclusion. The hybrid as an effective way of circumventing a controversy became itself a controversial frame. It is too early to tell how much lasting power the second interpretation of the insurance policy will have.

2. Moral Obligation to our grandchildren: A second representation of the discounting controversy was to re-frame it in moral language that centered on the world we leave to our children and grandchildren. In this formulation, the cost/benefit equation was reconfigured to reduce the distance between benefactors and recipients. Economists and others implied that when future generations are relatives, we assume more benevolence and less cold, rational, economically efficient behavior. The technical aspects of the social discount rate tend to fall away to be replaced by more morally based claims about the world we want to leave to our children and grandchildren.

This representation was illustrated with economist Stephen DeCanio's defense of an emissions reduction policy in a 1997 hearing. In this testimony, he placed the moral obligations of the current generation, environmental protection, and effective economic decision-making all in one package.

> The obligation of the present leadership to future generations goes beyond short-term economic calculations of costs and benefits. We have a moral responsibility to preserve the global environment for our descendants.
>
> Fortunately, we don't have to make a choice between economic opportunity and environmental protection. We have the means to move towards stabilization of the climate in a way that enhances technological progress and promotes economic growth. We have only to act reasonably, intelligently, and without fear. (DeCanio 1997, 152)

In another example, then Undersecretary of State for Economic, Business, and Agricultural Affairs Stuart Eizenstat presented the morally based argument after discussing the insurance policy idea in a 1998 hearing.

> In the case of global warming, we will not have a second chance. Failure to act could lead to irreversible consequences and we will be committing ourselves, our children, and our grandchildren to a very different planet, and they will never forgive us. (Eizenstat 1998, 5)

In a third example, Mark Chupka, Acting Assistant Secretary for Policy and International Affairs, Department of Energy, also combined insurance with moral claims during a 1997 hearing.

> [G]iven the high stakes that scientists tell us this problem holds for our children and their health as they grow up in the next century, we need to be open to measures that reflect a prudent common sense willingness to buy insurance against unacceptable costs. (Chupka 1996, 88)

Nicholas Stern himself used this framing in a written response to a senator who posed the question that perhaps we should allow future, richer and more capable generations to deal with this problem.

> [F]uture generations will not have an opportunity to share the costs of climate damages in our current one. The question, rather, is how long our generation should wait before taking substantial action to reduce risks for future generations--which of course include our current children and grandchildren among those to come later. Because of the stock of long-lived greenhouse gases we are building in the atmosphere the longer we wait to begin emissions mitigation the more difficult the task we pass on…. (Stern 2007)

As with the insurance metaphor, the obligations owed to our children and grandchildren rhetorically deflect the discounting difficulties that the intergenerational gap and distant future time frame pose. The rhetoric around the moral obligation of leaving a clean environment to one's children moves economic discounting into a more hybrid framework that combines economic decision-making with a morally-based every day practice of providing more for one's descendents than one expects in return. Both rhetorical forms reposition cost/benefit analysis so that discounting rates, and perhaps other controversial issues, become less controversial, if not irrelevant.

However, like insurance, the moral obligation frame may be repositioned to mean something different. Some evidence is emerging that it is in fact happening. In recent testimony before the U.S. Senate that followed testimony by Al Gore, Bjorn Lomborg pointed out:

> Basically Gore talks about our generational mission. And he talks about that we need to think about what is the future going to ask us. I think that is entirely right. We need to think about what is the future going to ask of us. He says they are going to say, what were you thinking? What on Earth were you thinking? Why weren't you concerned about doing the most good first? And I think that is entirely true.
>
> But of course what they are going to be asking us is why were you spending $180 billion a year doing virtually no good 100 years ago from now, where you could have spent so much more money on better things. I would like to compare this very briefly, for $75 billion a year we could solve all major basic problems in the world. We could give clean drinking water, sanitation, basic health care and primary education to every single human being on the planet. (Lomborg 2007)

3. Repositioning Capital Opportunity Costs: A third strategy was to reconfigure

economic analyses of short-term costs. In evaluating the costs of climate change policy, economists have used both top-down and bottom-up models. Top-down models examine the costs of a regulatory change by incorporating the proposed mechanisms for achieving it. These models have been developed for the economy as a whole and disaggregated across regional and industrial sectors. They model the required economic adjustments of a GCC mandate, emphasizing capital opportunity costs. Bottom-up models start from the standpoint of the technological opportunities created through a shift toward lower greenhouse gas emissions. These models examine how these new technologies, or other ways of doing things, move through the economy and calculate both the costs and benefits of that movement.

For the top-down models, discounting is essential. Capital opportunity costs are assumed in the short-term, which then escalate over time by the discount rate. Other goods and services must be reduced in order to meet the costs of pollution reduction. Bottom-up models view reduction in greenhouse gases more as an investment opportunity with potential economic benefits. Discounting benefits yields lower numbers because technological changes to meet greenhouse gas reductions are both a cost *and* a benefit. Other short- and long-term, but uncertain, benefits are added to the direct benefits of reducing global warming potential.

In hearings on climate change, the discounting controversy became less salient and more manageable the greater the emphasis placed on bottom-up models. For instance, in a 1997 hearing, economist Stephen DeCanio clarified some differences between top-down and bottom-up models, while emphasizing the importance of the latter in this instance.

> All of the commonly used top-down models are constructed in such a way as to include the assumption that reductions in greenhouse-gas emissions can only be purchased at the expense of a reduction in the output of other goods and services. In all the top-down models, the various sectors and agents in the economy are presumed to be

> operating in a perfectly efficient manner, so that if an additional constraint is placed on their activities (such as being required to reduce emissions of greenhouse gases), the amount of ordinary goods and services that can be produced must fall. This assumption that is central to top-down models is appropriate in some applications, but it has serious drawbacks if the analysis covers decades of time.
>
> The bottom-up method takes a different approach. Instead of assuming that existing patterns of production are optimal, this method recognizes that a variety of economic, institutional, organizational, cultural, and political barriers prevent firms and individuals from taking advantage of best-practice techniques. In particular, the bottom-up studies have focused on how much greater energy efficiency could be achieved if the barriers to cost-effective investments in energy efficiency were eliminated. Unlike the top-down studies, the bottom-up studies admit the possibility that some energy savings (and hence greenhouse-gas reductions) could be achieved without loss to the larger economy. (DeCanio 1997, 172)

In a 1996 hearing, Eileen Claussen also broadly considered the capacity for technological development to meet the problem. In this example, she responded to a question about then President Clinton's green lights program.

> Actually there are a great many technologies that save a great deal of energy. Quite honestly, this is a long-term issue. We are going to have to solve it over the long term with technology development and deployment over the longer term. There are ways to move forward on this issue that are not light bulbs, even though light bulbs actually can save a great deal. (Clausen 1996, 93)

This bottom-up technological focus has been at the center of congressional hearings on climate change in the 1990s and into this decade even while control of Congress and committee hearing agendas shifted to the Republican Party. Some sort of technological fix was perceived as essential to any GCC policy. But the expressed recommendation was to invest in technology that will produce other economic benefits in the short term thus reducing the cost equation of the policy. This concern was echoed by economic experts who emphasized that technology-driven agendas must be combined with a "no-regrets" orientation so that benefits other than greenhouse gas reduction could help rationalize the policy.[vii] For example, in a 2003 House of

Representatives hearing, Marilyn Brown of the Oak Ridge National Laboratory advocated the development of energy efficiency (measured by energy per GDP rather than energy per capita) over reducing carbon intensity of the energy system or carbon sequestration because it is now more cost-effective and yields a no-regrets policy.

> There was a study completed in the late 1990's by 11 national laboratories that used the typology I just mentioned, energy intensity, carbon intensity and carbon sequestration, and enumerated hundreds of specific approaches in each of those three categories, and concluded that there is a relationship between those categories, and the time horizon required to produce cost-effective solutions, and the most cost-effective solutions that exist today are in the energy intensity reduction category, that is, in the energy efficiency arena. It is going to take another decade or two, possibly three, for the other approaches to become cost-effective.
>
> So, let us talk about the no regret strategy you asked me to address. Many studies have documented that the Nation has a significant reservoir of cost-effective energy efficiency opportunities. Focusing on these technologies has been called a no regrets approach, because it promotes the investments—it promotes investments that would be good for the consumer and good for the environment. It is also sometimes called the double dividends approach for that reason. (Brown 2003, 29)

Brown further elaborated that the "no-regrets" approach was not a short-lived phenomenon. "Rather it can take the Nation well into the current century with climate-friendly solutions that will allow the economy to continue to grow." (Brown 2003, 35)

However, this technological development cannot be expected in the short-term. Anne Smith from Charles River Associates International (which has done economic modeling of climate change policy for some time now) noted that since only cumulative greenhouse gas emissions over the long-term matter for climate risk, near term mandatory caps create significant "cost-risks" without accompanying benefits. But once technologies are developed

> that can make massive emissions cuts affordable (even if still quite costly) then it will be possible to ''make up for'' reductions that we might not undertake today. Therefore the only reductions in emissions that make sense economically until zero-carbon energy becomes affordable as the mainstay of our energy system are those that are very cheap now.

> These considerations suggest that the most important long-term feature of any policy initiative is the impact it will have on investment in R&D and the development of new technologies to provide essentially carbon-free energy at an affordable cost. (Smith 2005, 83)

Through an emphasis on bottom-up modeling and no-regrets technological development, economic experts were able to shift capital opportunity *costs* to *benefits*. Discounting then became less of an issue since benefits were not solely confined to the distant future. The hybrid connections of a belief in a technological fix, no-regrets rhetoric, and bottom-up economic modeling made the controversy over discounting less politically relevant.

Conclusion:

Past research on scientific controversies has demonstrated that they often become more polarized in policy contexts. Policy deliberations spawn a social and cultural context where more extreme positions gain salience. The U.S. climate change case has been no different in this regard. However, the discounting controversy was often effectively repositioned and managed by experts and other policy actors, significantly reducing its salience. This paper has shown how these actors developed hybrid formulations that served as surrogates for debate over costs and benefits and discounting in the policy deliberations. These hybrids drew upon practical day-to-day economic decisions that lay people make about insurance, moral/ethical obligations about what we feel we owe our children and grandchildren, a paradigm for economic modeling, unbridled technological optimism, and rhetoric of no-regrets.

We have often interpreted policy deliberations over technical phenomena as complex

situations where science must somehow be combined with other forms of knowledge and value orientations without being polluted in the process. Difficulties and controversy often emerge when scientific knowledge, with its cognitive authority, is merged with other knowledge forms and values that have less universal appeal. However, the case described in this paper illustrates that hybrid combinations of science and non-science may sometimes be highly functional by allowing experts and other policy actors to shift away from areas of unsettled science to grounds where knowledge and policy advice become more definitive. We also see in this case an alternative means for handling policy-relevant scientific controversy than boundary work or some artificial means of closure. Economic expertise was on numerous occasions quite ably combined with politics not in the form of a boundary object per se but in hybrid forms that were politically useful. The way out of scientific controversy in this case came through its engagement with political dynamics rather than its exclusion.

Of course, once these hybrid frames are developed and become politically useful, they become potential targets to be reconstructed to mean something different. In both the insurance and moral obligations to the grandkids hybrids, we saw such activity. Like scientific expertise in general, these hybrid constructions are potentially moving targets. Consequentially, those who wish to move environmental policy forward, especially in difficult cases involving long term environmental consequences, need to be persistent in constructing new hybrid frames.

It also is interesting to note that these hybrid frames have the potential to travel back into the scientific community. I recently noticed an instance in which the insurance analogy was used in the professional economics literature (Howarth 2003). In this paper, Howarth argued that comparing returns available on emissions abatement and corporate stocks is conceptually

inappropriate. “More appropriately, emissions reductions should be considered as a form of insurance that safeguards the interests of future generations” (Howarth 2003, 378). This reference indicates the possibility that these environmental policy hybrids may eventually become boundary objects that carry conceptual weight in two arenas.

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Endnotes

i. In other documents like the IPCC reports, there are said to be two approaches to discounting – descriptive and prescriptive. A descriptive approach discounts by simply examining the behavior of people. A prescriptive approach asks what the discount rate *should* be given the type of problem that is faced. I expand this categorical scheme here because there is not complete agreement among economists within either of these categories.

ii. Thomas Brandt (1993) distinguishes between scientific controversies and science-based controversies. The former are controversies within science over the establishment of scientific facts. The latter involve public/political controversies for which scientific information is directly relevant. Of course, there are many occasions for both – where a public/political controversy exists that requires scientific information for which there exists a scientific controversy. Many features of global climate change fit into this latter category.

iii. Edmond (2001) emphasizes hybrid character of strategies, opinions, and claims that may emerge during trials. These phenomena cannot be understood as legal, scientific, or societal per se, but as situated and as a sight where scientific knowledge and social order are mutually constituted.

iv. In a personal interview, an economist with the CATO Institute indicated that there is political motivation for reducing the impact of discounting. "People who hate neo-classical economics hate discounting. Discounting undermines much of what the left wants to do."

[v] More precisely, they are unable to reject the hypothesis that interest rates follow a random walk.

vi. There are exceptions such as a situation where an individual with a history of illness and expected future illness is able to purchase health insurance under a group plan.

vii. There is the obvious irony, of course, that the government must initiate a no-regrets approach because of market imperfections, otherwise these actions would already be taken. These market imperfections are noted by economists and policy actors, but it does not deter them from advocating for a market-based solution.