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Equity and the Discount Rate in Climate Change Economics

Introduction:

From the comfortable perspective of the developed world, debates over climate change have become widespread within the scientific community among various disciplines. However, many regions around the world are facing the impacts today and working to adapt to the new normal. While it is challenging to attribute specific events to global climate changes, a short list of examples would include rising sea levels in Bangladesh, the depletion of fresh water sources in South Africa, and the intensity of the 2017 Atlantic hurricane season. Developing regions are first in line to feel the impacts of a changing climate for many reasons such as their geography, the strength of their social structures, or their increased dependence on natural goods and services. Vulnerability to climate change is dependent on both the changes to the environment in addition to the development level of the population effected. The dichotomy between those in the developed world who maintain a comfortable lifestyle underwritten on carbon emissions and those in the developing world dealing with a majority of the immediate impacts is one of the greatest moral questions of our time.

Solutions to climate change require an interdisciplinary approach built upon contributions from natural and social sciences and philosophy. In theory, economics has the ability to make significant progress towards addressing the problem. Climate change can be viewed simply as the result of a negative externality due to the disequilibrium between the costs facing an individual and the costs facing society. Welfare economics is built upon principles of efficiency and provides researchers with market benefit-cost analysis (BCA). The application of BCA to climate change policies is associated with a long list of challenges related to the uncertainty surrounding future predictions, the global scope of the problem, and the wide distribution of costs and benefits both spatially and temporally.

The focus of this research seeks to determine the best practices in determining climate change mitigation policies, and will focus on the role of the discount rate. A robust debate surrounding the practice of discounting exists. The complex, global problems surrounding climate change require creative and innovative solutions beyond the standard discounting techniques. The review also reveals the normative choices that are taking place within the economic analyses being done with regard to the discount rate. Through my analysis I will examine the prevalence of such normative choice and determine the best practices when determining the discount rate, and explore ethical considerations that have entered the economic research.

Climate Change as a Threat to Humanity

Anthropogenic global climate change challenges the integrity of the world we know. According to the Fifth Assessment Report from the Intergovernmental Panel on Climate Change (IPCC) "human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems."[1] The report asserts that causes of such changes to the climate system are overwhelmingly linked to human activities, mainly the increase in greenhouse gas emissions resulting from the burning of fossil fuels. Increased economic and population growth are linked to the steep increase in emissions, the report firmly states that these human actions are extremely likely to be the dominant cause of climate change.

The effects of climate change are being felt by both the natural environment and human systems across the globe through higher temperatures, rising sea levels and changes in

[1]IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp, doi:10.1017/CBO9781107415324.

agricultural outputs among numerous other considerations. These impacts have real impacts of human health and wellbeing, in addition to interfering with capabilities necessary for economic development. In addition, the report links climate changes to increased occurrence of extreme events, specifically "a decrease in cold temperature extremes, an increase in warm temperature extremes, an increase in extreme high sea levels and an increase in the number of heavy precipitation events in a number of regions."[2]

Predictions of future damages are not perfect and uncertainties remain regarding the accurate potential effects of remaining on our current trajectory of emissions. However, the scientific community is in agreement that actions must be taken immediately to curb emissions and prevent the likelihood of future damages which include "long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive, and irreversible impacts for people and ecosystems."[3] These impacts are likely to have their most severe impacts on disadvantaged populations across the globe. This is due to that fact that areas around the equator and in the Global South will feel the effects of a warming world first and in a more severe fashion because of the fact that a disproportionate share of world's poor reside here. These areas of the globe are characterized by lower incomes and increased reliance, and exposure, to the natural environment . In addition to geography, because these areas have lower incomes, they have less potential for resilience against climate change impacts.

Adaptation and Mitigation Policy Strategies

The crux of the problem revolves around CO_2 emissions, as a result this is the most common policy target from both natural and social scientists. The foundation of such polices revolve around adaptation and mitigation strategies which include a compilation of strategies that

[2] ibid
[3] ibid

address climate change and its associated impacts. The IPCC determined global mean surface temperature should not increase more than 2°C over pre-industrial era temperature levels. In order for this to happen, policies must be enacted to cause a steady decline in CO_2 emissions. Mitigation strategies may achieve this goal. Specifically, the IPCC recommends "40 to 70% global anthropogenic GHG emissions reductions by 2050 compared to 2010, and emissions levels near zero or below in 2100."[4] Specific policies include investments that "reduce energy use and the greenhouse gas intensity of end-use sectors, decarbonize energy supply, reduce net emissions and enhance carbon sinks in land-based sectors."[5]

As opposed to reducing the causes of climate change impacts, adaptation strategies seek to address their symptoms. These polices include investments that are place- and context-specific and ideally are integrated into mainstream policies that encompass public policy initiatives through a long-term perspective. Adaptation seeks to reduce a population's exposure to dangerous impacts from the climate by improving human development (health, education, etc.), poverty alleviation, and investing in physical, institutional and social infrastructure systems aimed at improving ecosystem resilience and disaster risk management.

Solutions from Welfare Economics

Climate change can be viewed as a perfect storm[6] requiring interdisciplinary collaboration in order to combat its potentially disastrous effects. As mentioned above, natural scientists have linked climate change to human activities resulting in unsustainable greenhouse gas emissions. Social scientists are tasked with designing policies to address this global need.

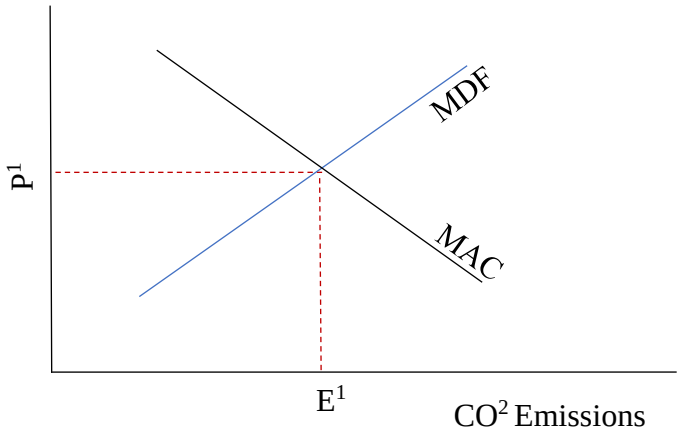
[4] ibid
[5] ibid
[6] Based on work produced

The discipline of economics has a vast array of tools that can be used to design cost-efficient policies that improve the wellbeing of all global citizens, these do not come without controversy.

Modern welfare economics is built upon the principles of utilitarianism and "looks first only at the consequences of actions and then assesses consequences in terms of impacts on utility."[7] Economics provides the market cost-benefit analysis (BCA) as a tool used to measure the effectiveness of a policy choice. In order to maximize social welfare for the greatest amount of people, a policymaker would seek to spend on mitigation policies or save for future abatement needs up until the point where marginal benefits of the policy equal the marginal costs. Specifically, this approach seeks to reach a Pareto optimum position, which occurs when there no longer remains the possibility of improving the wellbeing of one individual without harming another individual.

Economists are able to apply this method to climate change policies; in this context, the costs represent marginal costs of investments in mitigation strategies or saving for abatement policies (MAC) while the benefits represent the future damages that are to be avoided (MDF). As displayed in Model 1, this optimal level is the equilibrium point between the two curves. Depending on both the predicted damages of climate change and the estimated costs of preventing such damages, an economist can

Model 1:
Costs, Damages



[7] Beckerman, Wilfred, and Cameron Hepburn. "Ethics of the discount rate in the Stern Review on the economics of climate change." WORLD ECONOMICS-HENLEY ON THAMES- 8.1 (2007): 187.

determine the 'price' of future damages, labeled 'P^1" and in turn determine the optimal level of investments necessary to prevent such events, labeled as 'E^1' or the predicted level of emissions.

Governing bodies ranging from international associations such as the IPCC, to national and local governments are all responsible for the creation of a climate policy. The most effective way for a governing body to see the passage and implementation of such a policy is to argue its cost-effectiveness through a BCA report. In fact, a BCA is required in the U.S. as a result of Executive Order 12291 which was enacted by President Reagan in 1981. The order mandates that "regulatory action shall not be undertaken unless the potential benefits to society from the regulation outweigh the potential costs to society[8]." This requires a BCA for all policy proposals and is especially popular with those concerning the environment. According to Denning, "it is used ubiquitously entrenched in the evaluation process of international organizations such as the UNO, the World Bank Group, and the OECD."[9] This influential group of organizations helped develop the framework that is used today. The approach became widely used after economists developed this succinct framework by compromising numerous normative concerns which will be discussed below.

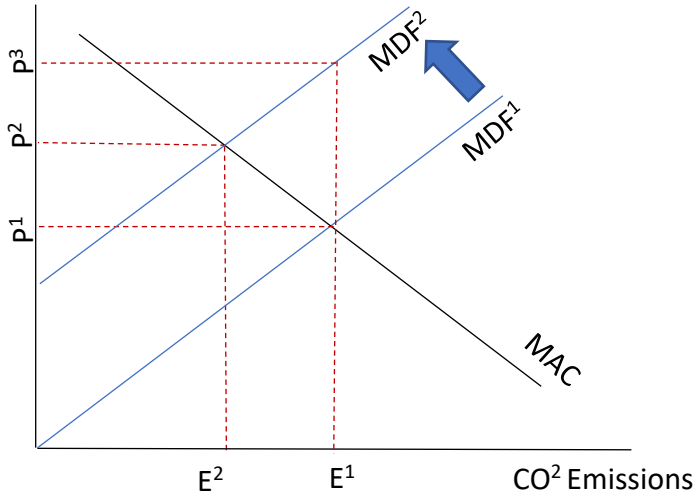
A key source of debate, and the main topic of discussion of this essay revolves around the proper way to assess future damages, as represented in the marginal damage (MDF) curve. In the context of integrating environmental concerns into economic analyses, John Krutilla proved influential due to his essay entitled "Conservation Reconsidered" published in 1967. At the time this piece was published, little attention was directed towards the concern of greenhouse gas emissions, but economists still were considering the impacts of Malthusian theories on

[8] Philip Shabecoff. "REAGAN ORDER ON COST-BENEFIT ANALYSIS STIRS ECONOMIC AND POLITICAL DEBATE." The New York Times, The New York Times, 7 Nov. 1981, www.nytimes.com/1981/11/07/us/reagan-order-on-cost-benefit-analysis-stirs-economic-and-political-debate.html?pagewanted=all.
[9] Dennig, Francis. "Climate change and the re-evaluation of cost-benefit analysis." Climatic Change (2017): 1-12.

population growth and environmental wellbeing. Krutilla proposed the idea of measuring the future costs and benefits of policies translated into the prices in the current period, "that is, current decisions on regulation affecting future generations should be predicated on the preferences and values of those now populating the earth's surface."[10]

The 'social cost of carbon' (SCC) plays a dominant role in determining future damages, specifically it is the "monetary indicator of the global damage done by the emissions of one extra ton of carbon today."[11] This topic has received vigorous academic attention and debate in order to determine the proper way to translate predictions from the natural sciences into monetary and economic terms. An increase in the SCC will cause the marginal damage function to shift up from MDF^1 to MDF^2, this action is displayed in Model 2. As a result, the cost of damages associated with a specific level of emissions increases for all levels. In the initial state, E^1 represented the most efficient state, the increased SCC increased the cost of damages from P^1 to P^3 indicating a steep increase in the damages from emissions. With the increased SCC and MDF, the model would suggest that the efficient state is associated with lower levels of emissions E^2. This would suggest that society should allocate increased funds toward

Model 2:
Costs, Damages



[10] Krutilla, John V. "Conservation reconsidered." The American Economic Review 57.4 (1967): 777-786.
[11] Guo, Jiehan, et al. "Discounting and the social cost of carbon: a closer look at uncertainty." environmental science & policy 9.3 (2006): 205-216.

strategies aimed at reducing the level of emissions. There are endless inputs that determine the SCC, one of the most influential components is the method by which an economist 'discounts' these future damages into the monetary terms of the current period.

Origins of the Intertemporal Choice Theoretical Framework

Today's economic analyses rely on assumptions determined over a lengthy historical debate surrounding psychological determinants of intertemporal wellbeing. When considering the ethical implications of an economic analysis, one must start with a brief background on the evolution of normative compromises that have occurred in the discipline over time.

Frederick et al. effectively review the extensive history and evolution of economic theory surrounding intertemporal choice. John Rae built upon Adam's Smith ideas in determining the wealth divergences across nations. Rae contended that particular societies have alternative preferences determining the accumulation of wealth through saving and investment decisions. The (i.) bequest motive and the (ii.) "propensity to exercise self-restraint"[12] promotes saving, while both the (iii.) "uncertainty of human life" (or the potential for extinction) and the (iv.) discomfort associated with delayed gratification deters saving.

These ideas led to the development of two theoretical frameworks: *anticipatory-utility theory* suggests that the anticipated utility of delayed consumption must outweigh the utility derived from immediate consumption for savings to occur while *abstinence theory* stipulates that the utility derived in the present is weighed equally to utility to be derived are weighed equally, therefore savings decisions solely revolve around the pain of delayed gratification.[13]

[12]Frederick, Shane, George Loewenstein, and Ted O'donoghue. "Time discounting and time preference: A critical review." Journal of economic literature 40.2 (2002): 351-401.
[13] Ibid

Eugen von Bohm-Bawerk built upon this work by contributing that "humans suffer from a systematic tendency to underestimate future wants."[14] He also pioneered the technique of modeling intertemporal choice in the same manner that an economist would use to weigh tradeoffs between two traditional goods such as housing and food. This transformed the discussion from one considering the psychological aspects of intertemporal choices to an increasingly technical analysis of the determination of consumptions over time. This frameworks effectively portrays the choices an individual or society makes when determining their present and future wellbeing.

These ideas were further detailed in 1930 by Irving Fisher who was an influential economist behind the Fisher equation which explained the relationship between the nominal and real interest rates. Fisher plotted the current and future consumption on an indifference diagram producing a marginal rate of substation. This development determined that principles of (1) time preference and (2) (diminishing) marginal utility of consumption are vital when calibrating intertemporal choice. Fisher argued that time preference is determined by Rae's four points in addition to (v.) foresight, or the "ability to imagine future wants"[15] and (vi.) fashion, the force determining one to save or spend have impacts on the saving rate. The model also exposes the principle of diminishing marginal utility, which states that with increasing levels of consumption an additional unit will provide less utility. Both of these findings will prove to form the backbone of economic analyses of climate change policy.[16]

Mirroring general trends in the economics discipline, theoretical discussions of intertemporal choice evolved from a careful consideration of psychological and normative

[14] ibid
[15] ibid
[16] ibid

motivations to becoming increasingly simplified in a technical manner. By 1937, Paul Samuelson had worked to condense these aforementioned psychological motives into a simple discount rate through his discounted utility (DU) model. DU allowed users to study intertemporal choice with more than two time periods and played a central role in leading to the formation of a single cardinal measure of utility. He creates an intertemporal utility function which sums the utility function of present consumption with that of *t* time periods which are 'discounted' using a single variable that incorporates the traditional motivations to save discussed above. [17]

It is important to note that Samuelson qualified his proposed function as he clearly stated that the function should not be used as normative model as it not designed to address welfare concerns. He also acknowledged that the function is not an accurate representation of observed human behavior. Samuelson did not design the discounted utility model to be used as the sole determinant of policy because its assumptions grossly disregard necessary normative and behavioral considerations. Unfortunately, these reservations were not realized by the field as the model became the entrenched framework in the work surrounding intertemporal choice.[18]

Implications of Discounting

As mentioned above, it is necessary for future costs and benefits to be discounted to present values in order to make accurate comparisons of tradeoffs. A tenet of modern economics focuses on intertemporal choice and the decision individuals makes between present and future wellbeing. These decisions appear in the financial markets through differing rates of return from investment decisions. When determining climate change policy, discounting plays a large role in decision making due to the future stream of risks and benefits associated with climate change. Economists have come to differing conclusions over how they choose to discount these future

[17] ibid
[18] ibid

considerations. The following table shows just how important the concept of discounting can be when considering costs and benefits long into the future.[19]

Table 1:Estimated Number of Future Benefits Equal to One Present Benefit Based on Different Discount Rates

Years in the Future	1%	3%	5%	10%
0	1	1	1	1
30	1.3	2.4	4.3	17.4
50	1.6	4.3	11.4	117.3
100	144.7	2,621,722.2	39,323,261,827	$4.96X10^{20}$

Table 1 shows that as the discount rate increases, the present value decreases. A simple calculation exists to convert the future value into present terms:

$$PV = \frac{FV}{(1+r)^t}$$

Where PV represents the present value, FV is the future value, r represents the discount rate, and t equals time. Using a 10% discount rate, 17.4 units of damage 30 years in the future is equivalent to 1 unit today. In this simple example, we would be willing to save or invest only one unit in order to prevent 17.4 units of future damage (or approximately 5.7% of the future value). As the discount rate is decreased, the magnitude of the present value increases. In the same example of a 30 year time period, the use of a 1% discount rate would lead to allocate one present unit to prevent 1.3 of future damage (or approximately 77% of the future value). This simplified example exposes the mighty task the discount rate is assigned.

Table 2: Estimated Present Value of Future Damages of $1,000

	1%	3%	5%	10%
Present Value	$2.05	$52.03	$7.60	$0.07
Future Value (100 years)	$1,000	1,000	1,000	1,000

[19] Cowen, Tyler, and Derek Parfit. "Against the social discount rate." Justice between age groups and generations 144 (1992): 145.

Table 2 also displays a simple example of the discount rate. Here, we imagine the resources we would devote to prevent $1,000 worth of damage from occurring in 100 years. As the time period increases, the role of the discount rate becomes exaggerated. Using a 10% discount rate, society would only be willing to allocate 7 cents towards preventing $1,000 worth of damage in 100 years. It is now necessary to further analyze the determinants of the discounting rate.

The Ramsey Equation

Competing assumptions which have been debated over the past century are condensed into the Ramsey equation, which is a simple tool used to determine the rate at which future costs and benefits are discounted:

$$SRTP = \rho + \eta c = r$$

where *SRTP* is the social rate of time preference, ρ, rho, represents society's pure time preference, *c* represents the expected growth in per-capita consumption, η is the weighting variable of *c*. In theory, the *SRTP* is equal to *r*, the marginal rate of return on investment. There are problems with condensing multiple considerations into one simple measurement. Economists have evolved their discipline into one dominated by mathematical and empirical work based on the observed world. However, the choice of ρ and η is clearly normative and determined by the the particular ethical philosophy subscribed to by the researcher. Once a discount rate is finally determined, the lower it is implies a higher present value of future damages associated with climate change, and thus warrants increased investments in mitigation and/or abatement policies.

Pure Time Preference

The pure time preference of consumption, or *rho*, "considers and compares welfare among generations."[20] Assigning a value of zero to *rho* assumes equal value to the wellbeing of present and future generations, meaning we as a society value the wellbeing of the next generation equally to that of our own and that of generations living thousands of years from now. This idea does not have full consensus among experts in the field. Another argument would be to admit an increased interest in the first successive generations over the one that follows that. This would imply a value of rho higher than zero, and would represent a shift away from strict utilitarianism.

Expected Growth in Per-Capita Consumption

The expected growth in per-capita consumption, or *c*, accounts for the likely possibility that future generations will have higher incomes. As consumption is expected to grow over time, this implies the need to discount future damages because of the increased incomes of the future generations which increased their resilience to climate change. Unlike ρ, this variable does not have an ethical component as it strictly based on market predictions. However, it is still quite difficult to determine the accurate rate of growth because of major uncertainty. In relation to the debate over climate finance, it is important to note the potential for incomes in the future to decrease, not increase, due to the effects of climate change on economic growth – this is true especially when considering the unequal variability in climate change impacts across the globe and across income groups. Therefore, this variable is also contingent upon a decision based on the economist's beliefs about future economic growth.

Eta

[20] Pearson, Charles S. Economics and the challenge of global warming. Cambridge University Press, 2011.

Eta, or η, accounts for "the strength of diminishing marginal utility of consumption."[21] This variable seeks to further explain the concept of diminishing marginal utility, or the phenomenon that at increased consumption levels, each additional unit of consumption provides us with lower utility. So an extra dollar of income provides higher levels of utility to someone with $10 than someone with $1,000. While rho attempts to describe our preferences for intergenerational wellbeing, eta is responsible for intergenerational concerns. The researcher's choice of eta will have lasting implications on where society directs their investments: to the needs of the current generation or that of subsequent generations.

Eta plays three key roles which are sometimes at odds with each other. First, because future consumption is expected to grow, eta attempts to account for that by determining the utility they will actually receive with increased consumption levels. Second, the variable measures our society's aversion to risk. Third, the variable allows economists to compare utility levels among populations across the world with widely different income levels.[22]

Determining η results in serious complications, as these three components must be condensed into a single variable. If consumption rates are expected to grow, a low η gives less weight to the fact that future generations are expected to have increased resources available to adapt to a changing climate. On the other hand, η also measures society's risk aversion, so a lower η implies that we do not worry about the future risks associated with climate change. A high η implies that we are averse to risk.[23]

This concept exposes a serious flaw in the Ramsey equation because if we are risk averse, this should warrant increased investments in climate change polices. However, a higher η will

[21] ibid
[22] ibid
[23] ibid

actually produce a lower discount rate after the Ramsey equation is calculated. This is a technical matter, but is important in exposing a key problematic assumption. It is challenging to account for various policy goals in one single equation, and nearly impossible when considering the competing variables at play in eta.

A more concrete example of the implications of eta are described in Table 3[24] displays the highest value that a member of a high income group would be willing to sacrifice in order to increase the income of a member of lower income group by $1. The table is separated into two scenario. In the second column the higher income group earns two times as much as the lower group; in the third column this magnitude is increased to 10. When eta equals 0 in both scenarios, the higher income group would only be willing to sacrifice $1 to increase the income of the lower group by $1 as well. As eta increases, those in the higher income groups are willing to sacrifice an increasing level of their income.

Table 3: Maximum Acceptable Sacrifice from Group A to Increase Income of Group B by $1

Eta	Group A Income = 2 * Group B Income	Group A Income = 10 * Group B Income
0	$1.00	$1.00
0.5	$1.41	$3.16
1	$2.00	$10.00
1.5	$2.83	$31.62
2	$4.00	$100.00
4	$16.00	$10,000.00

Ultimately, this discussion exposes the key normative decisions that economists are making regarding intertemporal choices. Are social scientists trained in ethical theories or qualified to make such normative decisions? It is clear a deeper consideration of the normative assumptions underlying modern economics is necessary. The discount rate plays a vital role in

[24] Gollier, Christian. 2008. "Discounting with Fat-Tailed Economic Growth." Journal of Risk and Uncertainty, 37: 171–186.

determining the amount of public funds that will be allocated to climate change policies, as indicated in the following graph which represents the equilibrium point between the marginal costs of abating climate change and the marginal costs of future damages. The choice of the discount rate may shift this theoretical curve up or down, but in reality will determine the levels of emissions that we as a society view acceptable.

BCA Critique

BCA involves a technical economic analysis of the policy proposal. The costs and benefits are monetized according to our willingness to pay. Climate change policies must account for a stream of investments that run long into the future and the potential for damages that will occur in the coming decades and centuries. Therefore, the analysis requires these future costs and benefits to be converted to their net present value. The major attractions of BCA are its ability to reach the most efficient outcome as it provides a simple determination of the economic solvency of a project.

There appear to be endless critiques to the approach from both those in the economic discipline and those outside, such as philosophers, environmentalist or human rights advocates. In short, BCA is criticized for placing a monetary value on objects that are outside traditional market forces, such as clean air and water or a human life. By reducing the value of objects to a measurement in willingness to pay, it is impossible to claim the impartiality of such an analysis because of wide income disparities among relevant actors in the analysis. Critics cite that summarizing a complex question into a simple economic ratio is overly simplistic and fails to account for other value judgements[25].

[25] Denning

These concerns are only exaggerated when BCA techniques are applied to the environment. As mentioned, it is quite challenging and controversial to monetize environmental goods and services into traditional market prices. When considering climate change, there are three areas that break up many of the assumptions that BCA relies on. The first is centered on the international scope of the problems and its policy solutions. Emissions from one country have effects across the entire globe, and historically higher-income countries have been the largest contributors.[26] This fact is at odds with predicted higher scale impacts that will likely effect lower income countries to a higher degree.

Another concern comes from the significant uncertainty regarding climate change and its impacts. Climate change has become a hyper-politicized issue in the United States and a major critique is the degree of uncertainty that is associated with reports from natural scientists, although it should be noted a strong consensus has been reached regarding key tenets of the 'debate'. A BCA can only be as strong as the inputs that enter into its calculations, thus it can be challenging to provide precise recommendations

d'Arge et al. built upon this thinking in the early 1980s by connecting the debate over cost-benefit analysis and the discount rate with the conversation surrounding greenhouse gas emissions. The authors note that "benefit-cost analysis has become an accepted tool"[27] among others that policymakers can use in determining optimal levels of emissions. However they note that varying ethical philosophies can produce a wide gap in results. This is especially true in the determination of the social discount rate where a bias can enter the equation in exporting today's ethical standards to future generations. This comprehensive review, decades old now, remains

[26] Jamieson, Dale. Reason in a Dark Time: Why the Struggle Against Climate Change Failed--and What it Means for our Future. Oxford University Press, 2014.
[27] d'Arge, Ralph C., William D. Schulze, and David S. Brookshire. "Carbon dioxide and intergenerational choice." The American Economic Review 72.2 (1982): 251-256.

relevant in reviewing the underlying normative assumptions that lead economists to place the discount rate near zero or choose a higher rate that resembles the real interest rate, around 5-6%.

Economist Thomas Schelling agrees with the tradition of using a discount rate for certain policies in essay published in 2000. However, he does not believe the simplicity of the discount rate can easily be translated onto the problem of global emissions. He argues it is a useful tool when determining the cleanup of a certain environmental hazard: “discounting with appropriate rates of interest is crucial to determining which sites are worth cleaning up, how much they should be cleaned up, how much they should be cleaned up, and when or in what order of priority of cleanup should occur.”[28] Schelling contends that this situation is an ideal example of when the discount rate is effective because there is an alignment between who is polluting and who is paying for the mediation efforts, “ it makes sense to ‘optimize’ the ‘investment portfolio’ by reference to appropriate discount rates.”[29]

Schelling argues against the idea of a time preference for present consumption over future consumption. His story follows that we may tend to prefer the wellbeing of our children over our grandchildren which would substantiate the practice of discounting the wellbeing of the grandchildren. He debunks this by claiming that the wellbeing of his children would depend on the perceived wellbeing of their children though. He compares the principle of differentiating these two groups separated by time as equal to discriminating between groups in the present that are separated by geography. The second principle that is incorporated into the discount rate is the change in marginal utility of consumption over time. The reason one would discount the future generations is that it is expected that the marginal utility of consumption for future generations

[28] Schelling, Thomas C. "Intergenerational and international discounting." Risk Analysis 20.6 (2000): 833-838.
[29] Ibid

will be lower because consumption is growing over time. One would discount the future because it may not be theoretically sound to redistribute income in that direction of higher income.

The UK and US have come to drastically different conclusions regarding the future damages associated with climate change, and thus have proposed differing policies to mitigate current emissions. In 2006, Nicholas Stern produces a lengthy report detailing the long term economic impacts resulting from climate change in a final document entitled the Stern Review on the Economics of Climate Change. Stern's report concluded that strong actions must be taken immediately to work to prevent what he estimates to be 5% reductions in global GDP per year, "the costs of stabilizing the climate are significant but manageable; delay would be dangerous and much more costly."[30] This work has sparked a decade long debate among economists, who as field tend to agree on the likely potential of negative economic impacts in the future, but disagree over the optimal levels of resources that should be diverted to prepare for this looming threat.

The most influential response to Stern comes from William Nordhaus, a prominent American economists at Yale University. Nordhaus notes the alarmists tone present in the Stern Review, and chronicles numerous problems surrounding Stern's analysis. The key difference between the two works surrounds differing choices in discount rates. Nordhaus states that "the Review proposes ethical assumptions that produce very low discount rates…. If we substitute more conventional discount rates used in other global-warming analyses, by governments, by consumers, or by businesses, the Review's dramatic results disappear, and we come back to the climate-policy ramp."[31] This climate-policy ramp was the widely agreed-upon strategy proposed

[30] Stern, Nicholas. "The economics of climate change: the Stern report." Cambridge, UK (2007).
[31] Nordhaus, William D. "A review of the Stern review on the economics of climate change." Journal of economic literature 45.3 (2007): 686-702.

by economists. It would enact moderate cutback in emissions in the short-term; over time the mitigation policies would become stronger as technology advances.

Nordhaus suggests alternative ethical considerations that Stern fails to consider. One framework is based on principles of sustainability. Instead of valuing the wellbeing of each generation equally, an ethical principle that break easily, this idea would suggest bestowing as much societal capital to the next generation that we inherited. This allows for the substitution of forms of capital such as technological, social, manufactured or natural. An alternative perspective would be to accept a Rawlsian approach which seeks to maximize the wellbeing of the generation with the lowest wellbeing. This would suggest increasing spending in the current time period to alleviate suffering among poor people today. This idea is based upon prediction of increasing per-capita consumption in the future which suggests that we do not need to invest as much in their wellbeing. This assumption has faults as it is hard to maintain the prediction when considering the chance for climate change to actually reduce future consumption levels.[32]

It is clear that both economic and ethical frameworks that deal with climate change and inter-generational justice have not matured. This is especially true when considering the case of the discount rate, which has been shown to have drastic impacts on economic recommendations for mitigation/abatement policies. Ultimately, the voice of future generations is not able to be heard. This concerns systematically breaks down a myriad of ethical frameworks including Martha Nussbaum's Capability Approach; Nussbaum admits that her theory needs the support of other researchers to boost the argument surrounding the discount rate.[33]

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[32] Nordhaus, William D. "A review of the Stern review on the economics of climate change." Journal of economic literature 45.3 (2007): 686-702.
[33] Nussbaum, Martha C. "Climate change: Why theories of justice matter." Chi. J. Int'l L. 13 (2012): 469.