BEYOND DISCOUNTING CLIMATE CHANGE

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ABSTRACT

The question of which discount rate to choose when it comes to calculating costs and benefits regarding climate change has been discussed among economists since at least the beginning of the 1990's. However, the issue of which discount rate to choose is not just an academic question, it also has major implications for climate change policy. In this paper I will show that there exists large disagreements among economists on which discount rate society should choose when calculating the costs and benefits of climate change. Moreover, because of large uncertainties, non-marginal effects, and specific aspects of the social welfare function commonly used in welfare economics, I suggest that we shift focus away from the choice of discount rates altogether. We should instead focus on the risk of possible limitations of people's freedoms and opportunities to lead valuable lives. This shift in focus will affect the way we normally reason when it comes to the economics of climate change.

Keywords: *discounting, climate change, Ramsey rule, freedoms and opportunities*

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1. INTRODUCTION

The issue of global climate change has raised a lot of concern since the beginning of the 1990's. There is an increasing awareness of the fact that our actions today may cause large impacts on human beings and nature in the future. Most climate models shows that the current stock of greenhouse gases in the atmosphere, together with the increasing rate by which we are adding to this stock, is committing the Earth to a rise of between 2–5°C in global mean temperatures, maybe even higher. The consequences for humans and nature of this increase in temperature are highly uncertain. The science estimates that the poorest countries and people will be the ones suffering the most from the effects of climate change. Climate change is thus likely to deepen global inequalities (Conceicao et al, 2007). Furthermore, since the earth has not seen temperature increases above 3°C for millions of years it is likely that the physical and human geography will be transformed, including changes in weather patterns, melting of ice caps and rising sea levels. These changes will affect human beings' possibilities of living at certain areas of the earth and we might experience migration of millions of people around the world. This may in turn result in severe conflicts (Stern, 2012). Consequently, we have seen an increased debate among economists, governments, and policymakers about what the right course of actions are in response to climate change. Both individual countries, as well as intergovernmental institutions such as the EU, are currently adopting policies that aim at lowering the emission of greenhouse gases. Since global climate change unfolds over a timespan of many centuries, calculations of costs and benefits, and hence recommendations about which policies to adopt, becomes extremely sensitive to the discount rate that is selected (Weitzman, 2009). Therefore, the question of which discount rate to use is of central importance when it comes to the economics of climate change. However, it is also a question with a highly uncertain answer – environmental economist Martin Weitzman even calls it "the biggest uncertainty of all in the economics of climate change" (Weitzman, 2007 p. 705).

In 1998 the Swedish government passed 16 environmental targets. One of them is *Limited climate influence*, which focuses on climate change. Regarding *limited climate influence* the government states that the goal is to stabilise the concentration of greenhouse gases in the atmosphere on a level that entails that human beings' effect on the climate does not become dangerous (proposition 1997/98:145). The 16 environmental targets are sub targets to the broader *Generational target* ('Generationsmålet'). The *Generational target* states that the goal for

Sweden's environmental policies is to hand over to the next generation a society in which the major environmental problems are solved (proposition 1997/98:145). The time frame is set to circa 2020–2025. It is also of importance that the costs for different environmental policies are considered, both costs for the state as well as for society as a whole.

In the spring of 2010 the second follow-up report concerning the *Generational target* was released (proposition 2009/10:155). Regarding *Limited climate influence*, and the economic effects of climate change, the report refers to *The Stern Review on the Economics of Climate Change* (hereafter called the *Stern Review*, or simply the *Review*)[1]. The Swedish government also refers to the *Stern Review* when it discusses the need for estimates of costs and benefits when judging economic efficiency of mitigating climate change (proposition 2008/09:162). Since the government states that costs are an important aspect of environmental policies it follows that it is of interest to look closer at what the *Stern Review* says regarding costs and measures to be taken against climate change, and also to assess whether the *Stern Review* can be used as basis for environmental policies that the Swedish government may adopt.

The main message in the *Stern Review* is that the benefits of strong, early action on climate change far outweigh the costs of not acting. The *Review* concludes that the overall costs of climate change, if we continue with business-as-usual, will be equivalent to losing at least 5%, up to as much as 20%, of global GDP each year, now and forever. However, the *Review* also states that there is still time to avoid the worst impacts of climate change, if governments and policy-makers take strong action now. Inaction, on the other hand, may create great damage to future generations, and particularly to the poorest people amongst them. The cost of action, the *Review* believes, can be limited to around 1% of global GDP each year (Stern, 2007).

Following the publication of the *Stern Review*, its conclusions have been seen as controversial among economists. Economists do not dispute the facts about climate change that the *Review* uses as the basis of its calculations, nor do they object to the conclusion that governments need to act more strongly than they do today. The disagreement is concerning the way the *Review*

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[1] The *Stern Review* was conducted by a team of economists lead by Sir Nicholas Stern and first released in the fall of 2006. The *Review* was commissioned by the British government as a way to get a better understanding of the economic challenges associated with climate change, and how these challenges could be met, both in the UK and globally (Stern, 2007)

discounts costs and benefits in its calculations – especially the low value of 1,4% that the *Review* uses as discount rate. Environmental economists such as Nordhaus (2007), Dasgupta (2006) and Weitzman (2007) argue that the discount rate used in the *Review* is, if not totally wrong, at least highly questionable. Nordhaus, for instance, asserts that the *Review's* conclusions do "not arise from any new economics, science or modelling. Rather, it depends decisively on the assumption of a near-zero time discount rate" (Nordhaus, 2007 p. 701). Nordhaus (2007), who favours a discount rate of around 6% to be used instead, goes on to state that the *Review's* conclusions will not survive if we substitute for a discount rate that is more consistent with the real interest rates found in today's marketplace. Therefore, he concludes that "the central questions about global-warming policy – how much, how fast, and how costly – remain open" (Nordhaus, 2007 p. 701).

The first part of this paper looks closer at the debate among economists and the question of: *which discount rate should society choose when it comes to the economics of climate change?* It will focus on the model for discounting that the *Review* adopts and the different arguments presented by economists and philosophers concerning which value to choose for the model's different parameters.

The second part of this paper analyses how the adoption of a different theoretical approach affects how we view the economics of climate change. I suggest that we move away from focusing on the choice of a discount rate altogether and instead focus on people's ability to live life in a way that they deem as valuable, and the threat to this ability that large-scale climate change poses. The social welfare function commonly used in welfare economics, which the *Stern Review* also adopts, sums up the aggregate of individual utilities – interpreted as happiness or desire-fulfilment – where utility is viewed as a function of consumption (Dasgupta, 2006). The underlying ethics of basic welfare economics state that the objective of society is to work out the policies that maximize overall social welfare, where social welfare depends on the utility of all the individuals in the population. This approach of maximizing utility is known as utilitarianism. The approach of only relying on utility as the basis of social evaluation has been criticised. Economist and philosopher Amartya Sen states that it "is one thing to see utility as important, which it must be, but it is quite another to insist that nothing else matters" (Sen, 2009, p. 282). Welfarism is actually a special approach to social ethics. Its focus on utility or welfare is both a defining characteristic as well as one of its major limitations. The same aggregate of overall social welfare

may be compatible with quite different social pictures concerning political systems, opportunities, freedoms and personal liberties. However, welfarism demand that the valuation of, for instance, different climate change policies gives no *intrinsic* importance to non-utility features such as opportunities and freedoms – welfarism only focus on the utility *associated* with these features (Sen, 2009). If climate change limits future generations' options of where to live and how to support themselves, and in some cases may even cause starvation and death, this is a limitation of their freedom to choose valuable and worthwhile lives. This limitation is not fully reflected in the standard welfare function that places no intrinsic value on different freedoms and instead focuses on utility derived from consumption. This paper therefore proposes a shift in focus. When dealing with the issue of climate change we should concentrate on the actual opportunities of living, instead of solely focusing on utility derived from consumption or income. The last part of this paper will therefore analyse the question of: *If we adopt a different theoretical viewpoint – away from utility and consumption and towards freedoms and opportunities – how will this affect climate change policy?*

2. THE DISPUTE ABOUT THE DISCOUNT RATE

The technique used to add and compare costs and benefits that occur at different points in time is called discounting. Discounting is central to the economics of climate change, since it allows us to compare the costs of controlling CO_2 emissions today with the benefits that might not start accruing for several decades. The way discounting is done is by converting future euros (or whichever currency we may see fit) into a common currency of equivalent present euros, by the use of a discount rate (Weitzman, 2009). Since climate change evolves over decades, even relatively small differences in the chosen discount rate strongly affects the calculations of net present value of different policies. Consequently, the outcome of climate change analysis, and the different policy recommendations that emerge from these analyses, depends critically on the discount rate (Arrow et al., 1995).

The conventional use of discounting in economics applies to the discounting of consumption of goods at different points in time (Nordhaus, 1997). Economists typically list two different reasons explaining why future consumption is held to be worth less than present consumption, and hence why we discount future consumption. The first reason is that we believe that future

generations will be richer, due to economic growth, and that the richer you are the less value you place on a unit of extra consumption. The second reason is due to "impatience", human beings normally prefer to derive pleasure today than to postpone it until tomorrow (Stern, 2007). The large impact of different discount rates is illustrated in table 1 below.

DISCOUNT RATE (% per year)	PRESENT VALUE OF €1000 RECEIVED IN X YEARS						
	1	5	10	50	100	200	500
1%	990.10	951.47	905.29	608.04	369.71	136.69	6.91
2%	980.39	905.73	820.35	371.53	138.03	19.05	0.05
4%	961.54	821.93	675.56	140.71	19.80	0.39	0.00
6%	943.40	747.26	558.39	54.29	2.95	0.01	0.00
10%	909.10	620.92	385.54	8.51	0.07	0.00	0.00

Table 1. The impact of discount rates in the economics of climate change

In determining the appropriate discount rate to use many economists use the Ramsey model, presented by economist Frank Ramsey (1928). In this model, the discount rate can be expressed as:

$$r = \delta + \eta g \qquad (1)$$

In this expression, r is the social discount rate that is used to discount consumption; δ is the pure time preference rate (also called the utility discount rate); η is the elasticity of marginal utility of consumption, which measures the relative curvature of the utility function, and g is the growth rate of consumption per capita (Conceicao et al, 2007). Each of these parameters will be analysed and explained more thoroughly later on in this paper. Although the use of a constant discount rate derived from the Ramsey rule is the conventional use of discounting when it comes to climate change, there are also alternatives. One such alternative is hyperbolic discounting. When using hyperbolic discounting the discount rate is not constant, instead it becomes smaller and smaller over time. Hence, the medium and far future become relatively more important in relation to using a constant discount rate. Having said this though, the Ramsey rule for discounting is the one used by the *Stern Review*, and it is also a model that many other environmental economists use in their calculations, albeit sometimes in somewhat modified

forms[2]. Most participants in the debate about which discount rate to choose when it comes to climate change agree that a good starting point is the Ramsey rule (Persson & Sterner, 2007). In this paper I will therefore focus on this discounting model.

The *Review* states that the advantage of using (1) as an expression for the discount rate is that it is very simple and that we only need to determine values for the three parameters on the right hand side of the expression to be able to determine the discount rate (Stern, 2007). On the other hand, the disadvantage of (1) is that it depends on some very specific simplifying assumptions regarding the underlying utilitarian social welfare function used, from which it is derived. The social welfare function that the *Stern Review* uses is:

$$W = \int_0^\infty u(c)e^{-\delta t}\, dt \qquad\qquad (2)$$

In this expression, W is overall welfare calculated across households and generations. When deriving[3] equation (1) from the social welfare function (2) we assume that there is just one representative household at each point in time (or a group of identical individuals); utility is only determined by consumption; utility is additively separable over time and that the utility function, $u(c)$, is unchanging over time (Stern 2007; Conceicao et al, 2007).

The Ramsey model is a model of optimal economic growth and in this model the objective is to maximize the sum of discounted utilities of different generations. The utility function, $u(c)$, states that utility is derived from consumption and the factor $e^{-\delta t}$ in (2) is the discounting of utilities of different generations at the rate of pure time preference. The Ramsey model shows that in a welfare optimum, the social discount rate, r, is determined by the three parameters δ, η and g (Nordhaus, 2007).

In the debate concerning which discount rate to use in the economics of climate change, it is no exaggeration to state that the dispute has focused on the proper values of δ and η. Although some

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[2] For example, Weitzman (2007) introduces uncertainty into the Ramsey model.
[3] For a complete derivation of the Ramsey rule see: Arrow et al. (1996, p. 134), Conceicao et al. (2007, pp. 20-25), or Perman et al. (2003, appendix 11.1).

focus has also been on the value of g, the growth rate of consumption per capita, it is mostly the value of the other two parameters that economists do not seem to be able to agree upon.

2.1 *The descriptive approach vs. the prescriptive approach*

The debate among economists about which discount rate to choose when applying equation r = δ + ηg can basically be divided into two different "camps" – the descriptive approach and the prescriptive approach.

The descriptive approach, which reasons from the left hand side of the equation to the right hand side, asks which combinations of the three parameters will yield a discount rate that is in accordance with real returns from investments and existing interest rates found on today's markets (Nordhaus, 1997). The descriptive approach also believes that the appropriate social welfare function to use, when making intertemporal choices that affect different generations, is to be revealed from evidence about decisions that people and governments actually make (Arrow et al, 1996).

The prescriptive approach, on the other hand, reasons from the right hand side of the equation to the left hand side. The prescriptive approach, starts with a social welfare function, like (2), and then make ethical considerations about the proper values of δ and η. From these considerations they conclude what the appropriate discount rate should be (Arrow et al, 1996). The prescriptive approach, that the *Stern Review* belongs to, is usually associated with a relatively low discount rate and thus tends to favour policies that suggest that we spend relatively more on climate change mitigation. The descriptive approach, that for instance Nordhaus is adhering to, is typically associated with a relatively high discount rate and therefore recommends relatively less spending on mitigation (Arrow et al, 1996).

Economists in general support the concept of discounting when it comes to analysing the economic effects of climate change, but what they cannot seem to agree upon is which of the descriptive and the prescriptive approaches that is better (Arrow et al., 1996). The difference in viewpoints between the two approaches can be helpful to keep in mind when we now start to examine the different arguments that have been put forward about the proper values of the

parameters δ and η. Climate change is an issue that effects us both between generations, inter-generational, as well as across generations, intra-generational. As we will see, the different ethical questions that arise when we are dealing with inter- and intra-generational considerations, is captured by the two parameters δ and η.

2.2 δ – the pure rate of time preference

The first parameter in equation r = δ + ηg is δ – the pure rate of time preference (also called the utility discount rate). This parameter has several possible interpretations. From the perspective of a single individual, δ measures a person's preference of deriving utility today rather than tomorrow. Seen from this viewpoint, δ is a measurement of "impatience" (Conceicao et al., 2007). However, when we are performing cost-benefit analysis of climate change, the individual perspective has little relevance. Within the time period of climate change we are not dealing with intertemporal allocation of utility within a single lifetime, rather we are deciding on which weights to attach to the utility of future generations relative to the utility of the present generation (Nordhaus, 1997). A zero value of δ means that we treat the utility or welfare of future generations equally to the utility of the present generation. Attaching a positive value to δ, on the other hand, reduces or discounts the utility of future generations. The reason for discounting the utility of future generations is given by the fact that these generations will be around only in the future. This is why δ is called the pure rate of *time preference* – we discount because of time (Dasgupta, 2008). Since we are making a choice of how to compare utility between generations, the choice of value for δ is basically an ethical one.

There is sometimes confusion and failure to distinguish between δ and r in equation (1), and it is important to clearly state the difference between them. The discounting of *utility* is measured by δ, while r is the more familiar interest rate used to discount *consumption* (Weitzman, 2007). If we give present and future generations equal weight, and thus choose δ=0, there is still reasons to discount future consumption. If we believe that economic growth will continue in the future, g > 0, future generations will be better off and we have cause to discount future consumption since an extra unit of consumption will not carry the same worth in the future compared to today (Arrow et al., 1996). Consequently, we are discounting future costs and benefits because living standards are improving – we might call this *growth discounting* (Nordhaus, 1997).

Many influential economists and philosophers have argued that attaching a positive value to δ is ethically indefensible. The argument states that if we choose a value of δ > 0 we are then favouring policies that discriminate against future generations simply on the fact that these generations are not present today (Dasgupta, 2008). Another argument for choosing δ close to zero states that any serious theory of justice and equality needs to take a universal viewpoint. And a universal viewpoint needs to be impartial regarding time – no time can count differently from any other (Broome, 1992). Ramsey himself wrote that pure time preference is "ethically indefensible and arises merely from the weakness of the imagination" (Ramsey, 1928, p.543). Other proponents of a value on δ close to zero are Pigou (1932), Solow (1974), Parfit (1984), Broome (1992), Stern (2007) and Dasgupta (2008).

The arguments *against* choosing δ equal to zero, or close to zero, are mainly of three different kinds; a mathematical argument, an argument about implausible saving rates and an argument about observed behaviour.

The first argument, the mathematical argument, states that we need δ > 0 or otherwise the integral in (2) will not converge. This means that with an increasing and concave utility function, the sum of future utilities may be infinite in the absence of a positive utility discount factor. Hence, without a positive value on δ, maximizing a social welfare function, like the one that the *Stern Review* uses, will lead to mathematical problems. However, since even a very small positive value of δ will resolve this mathematical issue, some economists argue that this particular argument carries little weight (Arrow et al., 1996).

The second argument states that a zero, or close to zero, value on δ will lead to implausibly high savings rate for the current generation. Dasgupta (2006) calculates that if we choose δ=0.1%, and η=1, this will lead to a savings rate of 97.5%. Based on his calculations Dasgupta concludes that a "97.5% saving rate is so patently absurd that we must reject it out of hand" (Dasgupta, 2006, p. 7). Bare in mind though that Dasgupta's calculations leave out uncertainty, technological change and population growth. Nevertheless, a savings rate this high is surely implausible. Nordhaus' (1997) calculations do not show savings rates as high as Dasgupta's but he also finds that the problem with a low value of δ is that it leads to dramatic increases in global savings rates. Nordhaus states that the current generation therefore needs to "lower its consumption and

increase its saving sharply as a means of attaining a distant environmental objective." (Nordhaus, 1997, p. 324). The core of this argument is that if we choose a low value of δ we thereby demand that the current generation makes large sacrifices, through lowered consumption, to improve the environment for richer future generations.

However, if we find that maximizing a social welfare function, with δ set to zero, leads to the conclusion that we should sacrifice our own present consumption and instead invest our resources for the future, this may still be no reason to use a positive value for δ. Parfit (1984) argues that if disproportionate sacrifices, due to implausible high savings rates, are to be avoided, this fact should be incorporated directly into the social welfare function that we use. This could be done for instance by stipulating a minimum level of utility or well-being that no generation should fall below. The social welfare function could thereby attach large negative values to any level of utility below this stipulated level. With a social welfare function of this form we would therefore not end up with recommended savings rates of 97.5%, even if we set δ equal to zero. Stern (2012) has responded, to the argument about implausible high savings rates, that if a model generates odd conclusions with δ equal to zero, well then it is usually something wrong with the model. The *Review* also responds that trying to solve the problem of high savings rates by adopting a higher value for δ, of say 3%, is very ad hoc (Stern, 2007).

The third argument, against setting δ equal to zero, states that we should look at people's actual preferences for present utility over future utility. This preference is revealed in people's everyday savings and investment behaviour (Weitzman, 2007). This argument declares that it would be wrong to base policy decisions on ethical arguments of zero pure time preference when this is not the way that society is actually behaving. Many social decisions are instead tilted in favour of the present generation (Nordhaus, 1997). A lot of people feel that it is right to attach more value to the well-being of themselves and those near and dear to them. They might even feel that it is not anything morally wrong with this – we can call this the "near-and-dear" argument. Extending this argument may suggest that society even *should* favour the present generation in its decisions. This third argument against setting δ equal to zero is related to the preceding argument about savings rates. If the assumption of a cloze-to-zero rate of pure time preference leads to implausible savings rates, that are inconsistent with observed savings behaviour, well then we should reject this assumption.

The *Stern Review* agrees that it is possible that people in their everyday behaviour reveal a preference for discounting the utility of future generations on the grounds that these generations are more distant in time. But, as stated before, the *Review* finds it hard to ethically justify this, and that individual decisions and behaviour have limited relevance when it comes to the issue of climate change (Stern, 2007). Broome (2000) thinks that the reason why economists refer to individuals observed behaviour is because economists are reluctant to take ethical positions of their own. A way to avoid this is by leaving the ethical judgements to "the individual preferences of the people who make up the society" (Broome, 2000, p. 2). Broome (2000) also states that people sometimes recognize that they are not always the best judges of their own interest, and that they therefore seek the advice from doctors and financial advisers. If so, why would we then not consult economists and philosophers on the correct value of δ? Parfit (1984) sees two important limits to the "near-and-dear" argument. First of all, we may give more weight to people close to us, but we are not entitled to count the well-being of others for nothing. Even the remotest stranger should be given some weight in our considerations, but discounting the utility of future generations at a positive rate of pure time preference entails that the weight we attach to the utility of future generations decreases towards zero. As with the argument concerning implausible savings rates, Parfit suggests that there should be some lower limit to which the utility of future generations cannot fall beneath. The second limit to the "near-and-dear" argument is that it does not apply to severe harms. Climate change may impose grave harms to future generations, and Parfit argues that we are not justified in imposing these harms simply on the grounds that future generations are not as close to us as the present generation (Parfit, 1984).

Opponents of setting δ close to zero have, based on these three, and other arguments, instead opted for a value on δ of around 2–3% (Weitzman, 2007; Nordhaus, 2007). Nordhaus has in recent years been using a starting value of 3% a year, a value that declines to about 1% a year after approximately 300 years' time (Dasgupta, 2006).

Lastly, before we proceed to discuss the second parameter η, I shall analyse the *Stern Review's* choice of setting δ equal to 0.1%. The argument, put forward by the *Review,* is that the only sound ethical basis for choosing a positive value on δ, and hence place less value on the utility of future generations, is the uncertainty of whether or not these generations will actually exist in the future. Human beings are always subject to an exogenous risk of extinction – a meteorite may

strike the earth – and therefore the present generation is justified in discounting future utility (Stern, 2007). The *Review's* choice of δ=0.1% is thus based on a probability that there is a 10% chance of human extinction by the end of this century. One might object that this argument seems to lead to counter-intuitive results. If climate change per se increases the risk of human extinction, this argument implies that we therefore should attach a higher value on δ and thus discount the costs of climate change at a higher rate. This seems unreasonable – the risk of extinction due to climate change would rather work towards a *lowering* of the discount rate. However, this objection is misguided since the argument used by the *Review* clearly states that the threat towards human existence must arise from some *exogenous* shock – something outside of the issue at hand (Stern, 2007).

2.3 η – the elasticity of marginal utility of consumption

The second parameter on the right hand side of equation r = δ + ηg is η – the elasticity of marginal utility of consumption (also called the rate of inequality aversion). This parameter measures the percentage change in marginal utility resulting from one percentage change in consumption. Hence, η is a measurement of how quickly utility drops in response to increases in consumption (Conceicao et al., 2007).

The social welfare function used by the *Review*, and specified in expression (2), includes a utility function, $u(c)$. In this function the parentheses indicates that utility is a function of consumption. Features of the utility function are that marginal utility is positive, $u'(c) > 0$, but declines as consumption rises, $u''(c) < 0$. These features imply that if consumption is higher for future generations, due to economic growth, the marginal valuation of this consumption will be lower. Just how much lower, we might ask? The answer to this question is given by the elasticity of marginal utility of consumption, η, which can be seen as a measurement of the relative curvature of $u(c)$ (Arrow et al., 1996). Mathematically, η is given by:

$$\eta = -\frac{u''(c)c}{u'(c)} \qquad (3)$$

The *Review* assumes that η is a constant (Stern, 2007). The class of utility functions for which η is constant is given by:

$$u(c) = \frac{c^{(1-\eta)}}{(1-\eta)} \qquad for \ \eta > 0, \eta \neq 1 \qquad\qquad (4)$$

$$u(c) = \ln c \qquad for \ \eta = 1$$

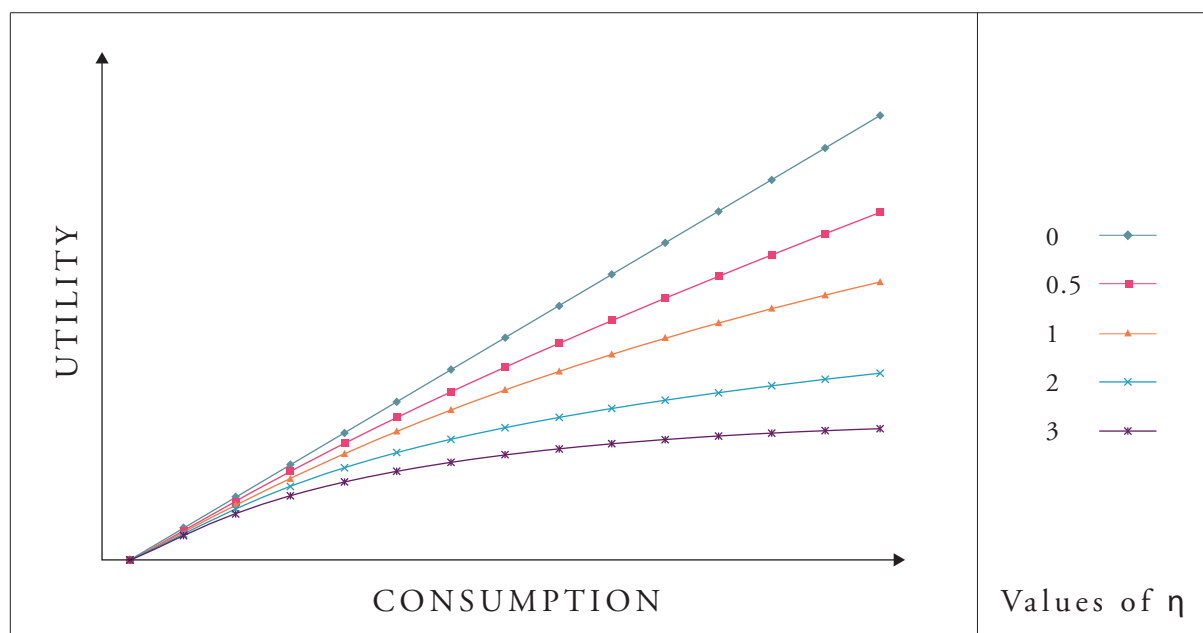
Figure 1. Utility function for different values of η. *Source:* Conceicao et al. (2007).

How different values of η affect the curvature of the utility function is illustrated in figure 1. We see that the higher the value of η, the faster marginal utility declines as consumption increases. So, a large value on η implies that marginal utility is very responsive to changes in consumption. With η=1 we get a logarithmic utility function.

As with the first parameter in expression (1), the second parameter, η, also has several possible interpretations. However, in all the interpretations, η is representing aversion in one form or the other (Conceicao et al., 2007). First, seen from the perspective of a single individual, η can be interpreted as a measure of personal risk aversion against fluctuations in future consumption. A large risk aversion against fluctuations in consumption is reflected in a high value on η. Someone that is highly risk averse is unwilling to allow its consumption to vary over time. Secondly, η can also be interpreted as to measure aversion against inequality between generations. Seen from this

perspective, η is about inter-generational equality. The higher the value of η, the more weight society gives to equality between generations, and vice versa (Arrow et al., 1996). With a high η and a positive growth rate of consumption per capita, g > 0, marginal utility declines quickly as consumption increases, and consumption becomes worth more to the present generation relative to the richer future generations. If society cares a lot about inter-generational equity and future generations are assumed to be much richer than the present generation, well then society is justified in discounting future consumption. Lastly, η can also be interpreted as to measure society's aversion against intra-generational inequality – consumption inequality amongst people of the same generation (Dasgupta, 2008).

As with δ, there is no agreement amongst economists about the proper value on η. The *Stern Review*, as well as Nordhaus, uses the value of η=1 in its calculations. With η equal to 1 we have a logarithmic utility function. Choosing η equal to 1 implies that if income rises by 1% the marginal utility from consumption falls by 1% (Arrow et al., 1996). Nordhaus and the *Review* refer to empirical research about consumer behaviour when they choose to set the value of η equal to 1. However, there is no consensus in the empirical literature about the correct value on η. Some authors refer to studies that show that the value on η lies in the range of 0.8-1.5 (Arrow et al., 1996) while others state that the proper value is more likely between 2 and 4 (Dasgupta, 2008).

The *Review's* choice of setting η equal to 1 has not escaped criticism. Weitzman argues that the *Review* is making an extreme choice and that the value of η=1 is in "the lowest lower bound of just about any economist's best-guess range" (Weitzman, 2007, p. 707). Weitzman (2007) states that the value on η is commonly assumed to be somewhere between 1 and 4 and he himself chooses η equal to 2 in his calculations. Dasgupta writes that "[t]o assume that η equals 1 is to say that the distribution of well-being among people doesn't matter much" (Dasgupta, 2006, p. 6). He goes on to argue that η=1 implies that the current generation should spend large amounts on the behalf of later generations, even if later generations are expected to be much richer and better off. According to Dasgupta (2008), it is not clear whether such trade-offs between generations are ethically reasonable. As noted above, η can be interpreted as a measurement of society's aversion against intra-generational inequality. Predictions about the consequences of climate change indicate that the poorest countries and people, most of them living in the tropics, will be inflicted

with far more damage than richer countries, living in the temperate zone. Because climate change will have a disproportionate negative impact on the poor, and since it is today's rich world that is responsible for the majority of greenhouse gas emissions, the rich world has a particular obligation towards tomorrow's people in the poor world. If society is concerned with intra-generational inequality, a higher η should then be used and urgent action be taken to reduce intra-generational inequality. Dasgupta (2008) argues that this reasoning demands us to increase the value on η to around 3. However, in this case, the higher value on η would work towards a lowering of the discount rate, a relationship between η and the discount rate which is not captured by the simple Ramsey model (Conceicao, 2007). Lastly, Dasgupta (2008) also criticizes The *Stern Review* for being inconsistent in so far as the *Review* chooses η on the basis of observed consumer behaviour but rejects observed behaviour completely when it comes to the choice of δ. When choosing a value for δ the *Review* is instead relying on ethical arguments. This inconsistency, Dasgupta writes, is "neither good economics nor good philosophy" (Dasgupta, 2008, p. 159).

In defence of the *Review* it is possible to argue however that even setting η equal to 1 is to give some emphasis to equity. With η=1 society will find it to be an acceptable trade-off to reduce richer generations' consumption with 10% for a 10% increase in the consumption of the relatively poorer present generation, even though the *absolute* reduction in consumption of the former is greater than the absolute increase for the latter (Arrow et al., 1996). Arrow et al. also states that it is standard to assume that the elasticity of marginal utility of consumption, η, lies in the range between 1 and 2 and that "no generally accepted view supports a different value of η" (Arrow et al., 1996, p. 141).

2.4 *g – the growth rate of consumption per capita*

The third, and last, parameter in the Ramsey model is g – the growth rate of consumption per capita. In equation $r = \delta + \eta g$ the parameter g can be seen as to represent the underlying technological progress that pushes the economy forward and creates economic growth. This interpretation of g, as representing technological progress, is common in modern post-Solow growth theory (Jones, 2002). A higher value on g, creates a higher social discount rate, r. Similarly, if consumption is expected to decline in the future compared to now, the discount rate

would be negative (Conceicao, 2007). Stern (2012) suggests that climate change may create negative growth in the future and that this would work towards lowering the discount rate we use today.

Compared to the dispute about the proper values to choose for δ and η there has been considerably less controversy about the growth rate of consumption. There is however much uncertainty and empirical problems involved when trying to forecast g, the future growth rate of consumption (Arrow et al., 1996). The *Stern Review* chooses g equal to 1.3% per year (Stern, 2007).

2.5 *Which discount rate should we choose?*

So, based on the preceding paragraphs, which discount rate should society choose when performing cost-benefit analysis regarding climate change? At this point it can be helpful to recapture the different authors' preferences of values on δ and η, and hence the resulting discount rate that they favour. Table 2 summarizes the choices made by some of the authors presented in this paper. When calculating the discount rate that results from these figures, I have used the *Review's* estimate of a consumption growth rate of 1.3% per year.

AUTHOR	δ	η	r
Nordhaus (1994)	3% a year	1	4.30% a year
Stern (2007)	0.1% a year	1	1.40% a year
Dasgupta (2008)	0	3	3.90% a year

Table 2. Discount rates in the context of climate change

It may seem there is not much of a difference between 1.40% a year and 4.30% a year. However, as was illustrated in table 1, a choice of either 1% or 4% makes a lot of difference when we are dealing with long run economic effects. The present value of a loss in consumption of €1000, resulting from climate change 100 years from now, is 18 times larger when discounted at 1% a year instead of 4% a year. It is now evident why, for instance, the *Review* and Nordhaus come to very different conclusions regarding the costs and benefits associated with climate change. Consequently, it is also of no surprise that economists so strongly disagree about the correct

policies to adopt in response to climate change. The *Review* recommends that the world spend substantial amounts today on climate change mitigation, while Nordhaus recommends us to invest a lot less today and instead ramp up the efforts considerably over time (Stern, 2007; Nordhaus, 1994).

The *Stern Review* argues that we should base our choices on ethical arguments while Nordhaus, for instance, claims that we instead ought to derive our discount rate from current market rates. Nordhaus (2007) argues that ethical reasoning is irrelevant when it comes to investments regarding climate change, and hence it would be more relevant to look at market rates. If we rely on ethical arguments, instead of revealed preferences and behaviour of citizens, we may also run into irreconcilable inconsistencies. For instance, many of us find it unethical that large oil companies make huge profits through monopoly power and the use of cartels. Does this imply that cost-benefit analysis should use $2 as the price of oil (Nordhaus, 1994)? Since there exists so much disagreement about the correct values of δ and η, would it therefore be easier, as the descriptive approach proposes, to skip the ethical arguments altogether and instead choose one of the rates that can be found in today's markets?

Using market rates in cost-benefit analysis of climate change is however not without problems of its own. One problem concerns which market rates of interest and return to choose, out of the wide range of options that exist in today's markets (Weitzman, 2009). Nordhaus (2007) generally uses the real return on capital, of around 6% per year, in his calculations and models. Broome (1992) writes that taking the discount rate straight from the markets is a form of "shortcut" and that discounting future consumption is usually done by using the market rate of interest available either to producers or consumers. By using this shortcut, society avoids to contemplate the ethical arguments about the proper value of δ and η. However, Broome (1992) presents a number of arguments of why he believes that this shortcut is not available in the context of climate change:

Firstly, market rates do not stretch far enough in time. The impacts of climate change make the concept of long run, steady state economic growth highly doubtful. Broome (1992) argues that we do not have any good reason to assume that interest rates will stay constant over the long time period that is involved. Most of the rates found in the markets today are, in relation to the time period involved with climate change, relatively short term and not relevant for the issue at hand.

Secondly, future generations do not participate in today's markets. The value of future consumption to future generations is therefore not represented in current market interest rates. At the same time, it is future generations that will benefit the most from economic policies that mitigate the effects of climate change. Consequently, the benefits accruing to future generations will not be accounted for in project evaluations that use market interest rates (Broome, 1992). The analysis of climate change concerns impacts *across* generations rather than within. The *Review* argues that we thus cannot rely on market rates and instead need to look at the ethical issues involved (Stern, 2007).

Thirdly, the effects of climate change are not marginal. Discount rates, as they commonly are used, are concerned with marginal effects (such as the economic effects from Ericsson's decision to by a new piece of machinery) and the impacts from climate change are not marginal but rather on a large worldwide scale (Broome, 1992). This argument is emphasized by the *Review* as a major reason why we cannot "read-off" the discount rate from market rates (Stern, 2007).

Lastly, and most importantly, Broome (1992) argues that market interest rates do not represent the true opportunity cost of capital. Rather, market rates represent the private return on investment, and this is different. Private investments often result in emissions of greenhouse gases, and these emissions create external costs for society in the form of climate change. Since these costs are not reflected in private rates of return on investments, the market interest rates that are derived from these returns are very likely overestimates of social rates of return. It is even possible that private rates of return could be positive for some time period, while, at the same time, social rates of return are negative (Dasgupta, 2008). Because externalities are by definition "outside" of the market, the use of market rates when it comes to climate change will probably be misleading (Broome, 1992; Dasgupta, 2008).

It seems that taking a "shortcut", and relying on market rates, has not lead us any closer to the objective of finding a correct discount rate to use in the economics of climate change. So we are once again back to the question we stated earlier: which discount rate should society choose when performing cost-benefit analysis regarding climate change? In this paper we have seen that the approach advocated by the prescriptive approach, that from ethical considerations conclude what the appropriate discount rate should be, is viewed as controversial among economists. Even if all

would agree that the prescriptive approach is the correct one, there still wouldn't exist any consensus concerning the proper values to use for δ and η. It is possible with ethical arguments to argue for both a low value on η, of around 1, as well as a higher value in the range of 3–4. On the other hand, the solution that the descriptive approach advocates, to derive the discount rate from existing market rates, is also not uncontroversial, as we have just established. Consequently, it seems that we cannot give a specific answer to the question of which discount rate society should choose when it comes to the economics of climate change.

Since the choice of a discount rate is of such great importance, and since there is also no consensus among economists about which discount rate is the correct one to choose, how should governments and policy makers reason in this issue? Should, for instance, the Swedish government let the future be decided by a roll of a dice? If a high number comes up on the dice: do less now about reducing greenhouse gas emissions and instead ramp up the efforts considerably over time. If a low number comes up: take strong action now and devote resources of around 1% of GDP each year to the reduction of greenhouse gases. Nonetheless, even if economists, policy-makers and governments all could agree upon which discount rate that is proper to use in the economics of climate change, would we thereby be convinced that they have made the "correct" choice? Does a correct choice even exist? Whatever choice we make we might still end up making the wrong one. When it comes to the issue of economic effects of climate change, maybe the correct procedure is not to choose a discount rate and then run a standard cost-benefit analysis? Maybe we must look at this issue from another viewpoint, and thus shift our focus away from the choice of a discount rate altogether?

It is not uncommon among economists to feel that there is something wrong with using traditional cost-benefit analysis, which involves the discounting of distant-future consumption, when it comes to the issue of climate change. Weitzman, for example, argues that to "think about the distant future in terms of standard discounting is to have an uneasy intuitive feeling that something is wrong, somewhere." (Weitzman, 1998, p. 201). He goes on to state that there exists few economists who have not sensed in their "heart of hearts" that there is something wrong with discounting future events using a constant discount rate gotten from extrapolating past rates of return of capital (Weitzman, 1998, p. 202). Other authors stress that the many "issues surrounding the debate of climate change cannot be fully captured by the discount rate", and that

"relying on such a controversial and complex instrument might not be the best tool for analysing the costs and benefits of climate change mitigation." (Conceicao et al., 2007, p. 19).

Based on the preceding analysis of the disagreements concerning the correct discount rate, it exists a few ways in which governments and policymakers may decide on this complex issue. They can pick one of the discount rates proposed, based on the merits of the arguments presented, and base their cost-benefit analysis and subsequent policy decisions on this discount rate. Or, as I will explain more thoroughly in the next part of this paper, they can move beyond focusing on the choice of a discount rate altogether and instead focus on the threat that climate change poses to future generations' opportunities and freedoms to live their lives as they deem valuable.

3. GOING BEYOND DISCOUNTING

There are three arguments that can lend support to the idea that we should move beyond focusing on the choice of a discount rate altogether: an argument about uncertainties, an argument about non-marginal effects, and an argument about the social welfare function.

3.1 *An argument about uncertainties*

The first argument, about uncertainties, states that the uncertainty concerning climate change is so large that it makes any estimates of the net present value of climate change mitigation being, at best, informed guesstimates. To begin with, there is the uncertainty regarding the effects on human beings and nature, such as changes in living conditions and changing weather patterns. There are uncertainties involved in every step; from what the future rates of economic growth will be, to the volume of emissions that will follow, the increase in temperatures resulting from these emissions, and finally the actual impacts on nature (Stern, 2007). We know that the earth is warming, but we do not know the full impact from this warming. Secondly, there are also uncertainties involved in trying to calculate the economic effects of these climate changes. Costs resulting from, for instance, an increased risk of flooding in some parts of the world is truly difficult to estimate. If it is hard to place a monetary value on some environmental damages there is a potential risk that these costs get ignored. Some effects on the environment will also be irreversible, and how do we estimate the cost of irreversible changes? The long time span involved

is yet another major reason why estimates of the economic effects of climate change becomes highly uncertain. Just imagine that you lived in 1912 and were asked to predict how the world would look today in 2012 and you get a feeling of how difficult it is trying to forecast how the world will look like a century or more from now. Lastly, we have the uncertainties surrounding which discount rate to use when calculating the net present value of the economic effects that will materialize many years, sometimes centuries, from now. A discount rate that, Weitzman states, is "more uncertain than predicted costs (or benefits) of climate change by about an order of magnitude." (Weitzman, 2007, p. 715). So, when we try to calculate net present values of future costs and benefits we have to deal with highly uncertain estimates, which we then discount using a discount rate that is even more uncertain. To quote Weitzman yet again, it now becomes apparent that "the economics of climate change is the greatest application of subjective uncertainty theory the world has ever seen." (Weitzman, 2007, p. 718).

Broome (1992) believes that the uncertainties surrounding the economics of climate change make the exercise of deriving a discount rate, from current economic theory, pointless. He also argues that performing cost-benefit analysis is self-deception when we are faced with uncertainties as big as these. Conceicao et al. writes that some authors think that the uncertainties are so deep as to overwhelm any other consideration and that the "entire framework of comparing income across time using a discount rate collapses." (Conceicao et al., 2007, p. 19).

3.2 *An argument about non-marginal effects*

The second argument of why we should look beyond discounting is an argument about non-marginal effects. This is the same argument as the one I stated when listing arguments against deriving a discount rate from market interest rates. Discount rates, as they commonly are used, are concerned with marginal effects, and also relatively short time spans (Stern, 2007). The impacts from climate change are not marginal but rather on a large worldwide scale and stretch over a time period of many centuries. So when it comes to the issue of large-scale climate change I believe it is wrong to apply discounting normally used for marginal changes.

3.3 *An argument concerning the social welfare function*

The third and last argument concerns the social welfare function that is regularly used in standard welfare economics and which forms the basis of the Ramsey rule. This social welfare function, like equation (2), is built upon the ethical theory called utilitarianism, where the objective is to maximize the sum of utilities (Gayer & Rosen, 2010, p. 261). The underlying ethics of basic welfare economics states that the aim of society is to work out the policies that maximize overall social welfare or utility.

The utilitarian notion of value, which implicitly or explicitly is invoked in standard welfare economics, gives intrinsic importance only to individual utility. Individual utility, in turn, is defined in terms of some mental condition, such as pleasure, happiness or desire fulfilment (Sen, 1995). Sen (2009) states that there is something peculiar with the approach of giving intrinsic value only to utility or happiness in the assessment of public policies. Doing so we thereby neglect the importance of freedoms and opportunities, for example the opportunity to have free or affordable school education or basic healthcare (Sen, 2009, p. 282). If we focus solely on the sum of utilities when assessing public policies we fail to realise that the same amount of utility may go, in one case, with some serious limitation of valuable freedoms, but not in another (Sen, 2009). Nevertheless, standard welfare theory demand that the valuation of, for instance, different climate change policies gives no direct importance to non-utility features such as opportunities and freedoms. However, the freedom of being able to choose one's occupation or where to live are freedoms we typically value. Climate change might decrease some people's options on where they can live (people may have to move due to droughts or flooding) or how they support themselves (some areas of the earth could become less suitable for agriculture which affects people supporting themselves as farmers). Also, Stern (2012) states that one of the biggest concerns regarding global climate change is the risk that it might lead to large-scale loss of life. If our assessments of climate change policies focus solely on utility via the standard utilitarian welfare function, we fail to capture these limitations of people's freedoms.

So, if we give intrinsic importance to freedoms and opportunities and not solely focus on utility this affects the usage of the Ramsey rule. The Ramsey rule is derived from a utilitarian social welfare function, and if we question the assumptions underlying this welfare function, this in

turn cast doubt on the usage of a discount rate gotten from the Ramsey rule. Utilitarianism is a much-disputed theory (see Parfit, 1984, for a review of many of the issues discussed), and we should be aware of the fact that there exist many other ethical theories besides utilitarianism. Nordhaus (2007) argues that the acceptance of utilitarianism, as the proper ethical theory to use, is not as universal as the *Stern Review* would have us believe, and that alternative ethical perspectives provide quite different recommendations about optimal climate change policies.

These three arguments, about uncertainties, non-marginal effects, and the underlying social welfare function, form the basis of my proposal that when it comes to the issue of climate change we might need to look beyond discounting. We may also need to look beyond the effects on utility, as derived from consumption or income. If we focus merely on the effects on utility when we assess the impacts of climate change we fail to capture one of the important aspects of climate change – namely its impact on people's freedom and opportunity to live a life they see as valuable. In the next section I will outline how a framework that attaches intrinsic value to opportunities and freedoms may look like.

3.4 *Resources, opportunities and freedoms*

The ability to live a life that one sees as valuable depends on having resources, opportunities and freedoms.

To begin with, we need the resources or goods that are necessary for our survival. We need, for instance, food, clothing and a roof above our head. The relevance of having access to these "basic" goods may seem rather self-evident. However, the absence of these goods has a severely disabling effect on a person's ability to pursue a worthwhile life. In extreme cases, their absence could make valuable activities impossible altogether (Raz, 1995).

Secondly, we need access to a wide array of options or opportunities from which we may choose. This includes, for example, the opportunity of education and receiving health care. Access to a wide range of different educations is important to develop the skills and knowledge needed for various professions. Education also improves a person's ability to earn an income and avoid being limited by poverty (Sen, 1999). The society in which we live is a major determinant of the

amount of opportunities and options that we face. Governments can help people flourish by guaranteeing that an adequate range of options is available to all (Raz, 1995). Even if I believe that education for my children is important it is very difficult to supply this education myself, and I need the help of society to provide this option. Besides society, the environment also influences what we can do with our lives and the range of options available to us. Furthermore, the opportunities that the environment provides us with may be worsened by pollution or climate change. For instance, climatic circumstances, such as temperature ranges, flooding and droughts, can influence what a person gets out of a level of income or goods (Sen, 2009). If we focus on utility as derived from consumption of goods we fail to recognize that a certain amount of income or goods can create very different opportunities for someone living today in relation to someone living "tomorrow", a tomorrow which might be affected by climate change. Future generations may have to devote a part of their income just to adapt to the changes in the environment. For example, they might have to build houses more resilient to extreme weather, invest in air condition systems or simply move to more habitable areas. So, the same relative amount of income or wealth can provide us with quite different opportunities, depending on where, and when, we live.

Lastly, different kinds of freedoms are an important part of a valuable life. The kind of lives that we manage to lead is not as valuable to us if we are not free to choose them ourselves. Besides valuing the freedom of choice for ourselves we also typically value the political freedom of being able to elect our political leaders in democratic elections. Standard welfare economics that focuses on utility do not commonly emphasise the value of political freedom. If I have the same relative amount of utility or happiness, I am viewed as equally well off irrespective if I am living in Sweden or a single-party state such as China. Most people value the possibility of selecting their own leaders, and would argue that this freedom is of intrinsic importance.

Opportunities and freedoms are closely linked. The opportunity to educate yourself or learn a specific trade is of little value if you are not free to pursue this opportunity. This kind of limitation of freedom has often, for example, befallen women throughout history.

I want to emphasize that I do not believe that there exist *one* way of living that is more valuable than others. I think it is important that a person is free to choose the kind of life that they want

to live and find valuable, whatever that may be. There are political philosophies, such as communitarianism, that believe otherwise and that society should promote one particular notion of *the* good life (Kymlicka, 1990). I am more in favour of the liberal idea that states that the only way to respect people as moral beings is to allow them to decide over themselves (Kymlicka, 1990). Liberal philosopher Isaiah Berlin formulated this viewpoint beautifully by stating that "[t]he only freedom which deserves the name is that of pursuing our own good in our own way" (Berlin, 1969, p. 94).

Another liberal principle states that our freedom is bound by the notion that we shall not inflict harm onto others. It is morally permissible to restrict the freedom of someone's actions if this restriction is necessary to prevent someone else from being harmed, even if the possibility of harm is fairly small (Parfit, 1984; Stern, 2007). Each person makes a moral mathematical mistake if she believes that there is nothing wrong with an act just because his or her action creates very small, even trivial, effects onto others. Instead, what we need to ask ourselves is this: "Will my act be one of a set of acts that will *together* harm other people?" (Parfit, 1984, p. 86). The answer to this question might be a definite Yes, and the harm to others may be great. A prime example of a situation where the effect of an individual act is small, but the combined effect from a large set of acts could be substantial, is the emission of greenhouse gases. If my way of life today creates emissions of greenhouse gases, which in turn leads to climate change, then my actions might be harmful to others. I therefore have a moral responsibility to try to prevent this harm from occurring. If my way of life directly affects future generations' opportunities and freedom to lead the lives they have a reason to value, then my way of life is not in accordance with the liberal principle that I shall not inflict harm onto others. This kind of reasoning can be used to lend support to policies that try to lower greenhouse gas emissions.

3.5 *Equal opportunity for welfare and the Capability approach*

To focus on opportunities and freedoms, instead of utility, income and consumption, is an idea that has been around since the beginning of the subject of economics (Sen, 1999). It is later on that the "discipline of economics has tended to move away from focusing on the value of freedoms to that of utilities, incomes and wealth" (Sen, 1999, p. 27). There exists, however, contemporary theories that focus on the opportunities that people have to lead worthwhile lives.

Richard J. Arneson's theory of *equal opportunity for welfare* stresses the importance of facing a wide range of available options for "preference satisfaction". He believes that society should strive towards equal opportunity for welfare, and he defines opportunity as "a chance of getting a good if one seeks it" (Arneson, 1989, p. 85). A theory similar to Arneson's, but perhaps more well-known, is Amartya Sen's *Capability approach.* The focus of the capability approach is on what individuals are able to do – their capabilities and freedom to live a life they have reason to value (Sen, 1999). He describes the capability of a person as dependent on a variety of factors, including personal characteristics and social arrangements (Nussbaum & Sen, 1993). Sen exemplifies the importance of capabilities by contrasting the different opportunities that face a disabled person compared to an able-bodied person. He argues that a disabled person cannot function in the same way as an able-bodied person can, even if they both have exactly the same income (Sen, 1995). Also, if a person is handicapped by some serious physical disability, but have a very high income, Sen thinks it is wrong to view this person as advantaged since he or she has difficulty in turning this income into "good living" (Sen, 2009, p. 234). Sen is hence critical about how economic theory tends to focus on income or wealth, instead of human life and the actual opportunities of living (Sen, 2009).

It is quite possible that there is not much of a difference between my thoughts about the value of focusing on resources, opportunities and freedoms and, for instance, Sen's Capability approach (except for the obvious reason that Sen is a Nobel laureate and I am not). However, that different presented theories are similar to each other is fairly common[4], and of no importance for the discussion in this paper. What is important is the main message, which I want the reader to take away from this paper, that when it comes to climate change we may need to stop focusing on discount rates and the effects on utility and consumption and instead focus on freedoms and opportunities.

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[4] The capability approach have been accused by philosopher Ronald Dworkin to be the same theory that he himself has developed and which focuses on *equality of resources* (Pierik & Robeyns, 2007). Arneson (1989) writes that *equal opportunity for welfare* is very similar to the capability approach, and a lot of Sen's ideas can be traced back to writings by Aristotle.

4. EFFECTS ON CLIMATE CHANGE POLICY

Policy recommendations put forward by environmental economists, such as those presented by the *Stern Review*, are all based on similar models. They estimate future costs and benefits which they discount using a preferred discount rate. Based on their calculations they present their idea of optimal climate change policy. Their climate models are built upon the standard analysis of focusing on consumption, discounting, and maximization of utility or welfare. The difference among them being that the prescriptive approach derives the discount rate from ethical reasoning regarding the values of the parameters in the Ramsey rule, while the descriptive approach derives the discount rate from current market rates. If we adopt a different theoretical viewpoint – away from utility and consumption and towards freedoms and opportunities – how will this affect climate change policy?

First of all, as stated in chapter 3.3, a different theoretical viewpoint will affect the usage of the Ramsey rule when deciding which discount rate to choose. The Ramsey rule is derived from a utilitarian social welfare function, where intrinsic importance is given only to utility or happiness. If we instead adopt a framework that attaches intrinsic value to freedoms and opportunities this in turn challenges the usage of the Ramsey rule.

Could we not just change the utility function, and make it incorporate freedoms and opportunities, and thereby we would still be able to perform public policy analysis in the same manner as before? There is one big problem with this solution. The standard welfare function is still of utilitarian form. And the objective of the decision-makers are still to maximize overall social welfare or utility. If we incorporate freedoms and opportunities into the utility function we thereby view them as only instrumentally important. Freedoms and opportunities are then perceived only as means to the intrinsic vale of utility or happiness. However, the framework of focusing on freedoms and opportunities sees these non-utility features as having intrinsic value – they are not means but ends, valuable for their own sake. So, if the framework we use to assess public policy is utilitarian, which value different policies with regard only to their consequences for human utility, this seems to be incongruent with a theoretical viewpoint that focuses on the intrinsic value of freedoms and opportunities. So it seems that modifying the utility function to incorporate freedoms and opportunities is not a feasible solution. Not as long as our assessment of public policies uses the standard analysis of focusing on maximization of utility or happiness.

We may still not be convinced that a different viewpoint would exclude the use of discounting. Would it not be possible to care about freedoms and opportunities and still use a discount rate derived from market rates? This would of course be possible. I see no obvious difficulty in combining the reasoning put forward by the descriptive approach about the usage of market rates, and the theoretical viewpoint that I have presented above. However, due to large uncertainties and non-marginal effects, there are difficulties in using discounting, in whatever form, when it comes to the issue of climate change. A way to get around the problem of uncertainties would be to use discounting only for the foreseeable future (e.g. the next 40 years or so). This alternative is not much use to us though since the effects of climate change concerns a time span of many centuries. Also, most climate models that use a discount rate derived from market rates is still valuating different policies based on similar welfare economics that the *Stern Review* adopts. Nordhaus use market rates when he calculates the effects of different public policies using his climate model called DICE. The objective of the calculations using the DICE model is to look at which policies that maximize a social welfare function, where the social welfare function is the discounted sum of utilities of per capita consumption (Nordhaus, 2007). So, the climate models that commonly use market rates also do not view freedoms and opportunities as intrinsic values.

So, how would a different theoretical viewpoint affect the basis of public policies regarding climate change? If we focus on freedoms and opportunities the relevant issue would not be on how we discount future losses of consumption, and in turn how this affects aggregate utility. Society would instead focus on the threat that climate change pose to future generations' opportunities to lead valuable lives. As stated earlier, climate change may impose limitations on people's lives. I believe that we have a moral responsibility in trying to prevent this from happening. Therefore, the best way to look at the issue of which policies to adopt in response to climate change may be to view it as an insurance situation. We spend money today to lower the emissions of greenhouse gases and thus try to stabilize global warming and thereby reduce the risk of limiting future generations' opportunities and freedoms. Since we do not know the full extent of the impacts on humans and nature from increased concentrations of greenhouse gases in the atmosphere, we are thereby exposed to a risk. Policies and projects that reduce emissions will reduce this risk. So, adopting policies to lower emissions will make us less uncertain about the future and consequently they act like insurance (Broome, 1992).

As we have seen in this paper there are large disagreements about the correct choice of a discount rate, and calculations using cost-benefit analysis is faced with large uncertainties. Also, since the effects of climate change stretch out over centuries, one choice or another of a discount rate can defend almost any recommendation of climate change policies. Consequently, the guidance offered by environmental economists to policy makers has been conflicting. Although the government bills concerning *Limited climate influence* includes references to the *Stern Review* the environmental target is not based on estimates from cost-benefit analysis. Sweden has instead based their climate change policies on a temperature target. The goal for Sweden's policies is to limit global warming at 2°C above preindustrial levels (proposition 2009/10:155). Adopting a temperature target is an alternative to discounting, in whatever form. With a temperature target, of say 2°C, society has an exogenously set mitigation objective and then tries to find the least cost measures to achieve this exogenously set target. So, in practice, the Swedish government does not base their policies on cost-benefit analysis.

I think it is plausible to adopt a temperature target and support this target with reference to the above reasoning about insurance. If society refer to the effects on people's actual abilities to live worthwhile lives this may act as a stronger foundation for climate change policies than reference to traditional cost-benefit analysis. However, this approach would still be vulnerable to the kind of criticism put forward by Nordhaus, that "the central questions about global-warming policy – how much, how fast, and how costly – remain open" (Nordhaus, 2007 p. 701). This is true, but if we adopt a different theoretical framework we focus on the issue from a new point of view. The focus on discounting and loss of future consumption has diverted attention away from the fact that global warming may lead to large-scale loss of life and severe limitations of people's opportunities and freedoms. It is perhaps the final evil of the effects of climate change that some people are thereby cheated of the chance others have had to make something valuable of their lives. That is what environmental policies need to address.

5. SUMMARY

The first part of this paper looked closer at the debate regarding which discount rate to choose when it comes to the economics of climate change. I used the results, assumptions and arguments presented in the *Stern Review* as a starting point to analyse the arguments put forward by the prescriptive approach and the descriptive approach. The prescriptive approach argues that we need to use ethical reasoning when trying to establish the proper values of the different parameters that form a part of the Ramsey rule. Analysing the different arguments put forward, it is obvious that there is no consensus among economists and philosophers about what these proper values should be. Further, I analysed the view, put forward by the descriptive approach, that we should skip the ethical arguments altogether and instead choose one of the rates that can be found in today's markets. This "shortcut" proved to be troublesome as well. The conclusion to be drawn is that there exist large disagreements and uncertainties among economists on which discount rate society should choose when calculating the costs and benefits of climate change. Disagreements and uncertainties, which in turn create very different policy recommendations about optimal climate change policies.

So, how should policymakers reason when it comes to the economics of climate change? Because of large uncertainties, non-marginal effects and specific aspects of the social welfare function commonly used, I suggest that we shift focus away from the effect on utility and consumption and the choice of discount rates altogether. Instead, we should emphasise the risk of possible limitations of people's freedoms and opportunities to lead valuable lives. Adopting a different theoretical viewpoint will affect the way we normally reason when it comes to the economics of climate change. Instead of discounting future losses in consumption we focus on potential limitations of freedoms and opportunities. This shift in focus might lend support to the idea that the best way to look at policies concerning climate change mitigation is to view them as insurance.

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