On Borrowed Time: Future Generations and the Net Zero Transition

BRIEFING PAPER

June 2022

By Bill Anderson-Samways and John Hobby

The transition to a net zero economy will take decades and involve costs over a similar timeframe. That raises questions about when those costs should be paid, and by whom. But vital decisions regarding net zero and the role of current and future generations are often muddied by dry, inaccessible language. This paper aims to set out a plain-language summary of how to think through two questions with critical implications. *How much* should we to pay now, to avert future costs? And *how* should we pay, given a choice between carbon pricing and borrowing?

KEY POINTS

- **Policy assumptions about future generations and net zero should be open to public debate.** They are not simply a technical matter for HM Treasury.
- The key assumptions concern: **moral attitudes towards the future; feelings about inequality and risk; and the scale of future GDP growth and climatic risks.**

RECOMMENDATIONS

- If HM Treasury's Net Zero Review assumptions hold true, **the UK should be spending much more on climate mitigation now to avert future costs.**
- **In particular, the UK Government should reduce the "discount rate", and alter the methodology used to calculate it.** As at present, the discount rate should not be used in many areas of UK policy – for example, target-setting and carbon-pricing.
- **Carbon pricing should be greatly expanded by the mid-2020s, ensuring a "Net Zero-consistent" carbon price** to avoid climate-related risks to future people. This will also raise significant revenues, thereby **avoiding an over-reliance on "borrowing from the future" without sacrificing mitigation.**

INTRODUCTION

Overview

Climate change is an intergenerational problem, involving severe risks to future people. Unless action is taken now, the climatic conditions in place when future generations are born are likely to be harmful to the wellbeing of those generations, and not susceptible to any action that those generations can take. The decisions we make today will have significant consequences for those who will come after us.

There are clear social and moral questions that arise from this situation. But Government decisions on net zero and future generations are often dry and inaccessible, shrouded in the technical Treasury-speak of "discount rates" and public debt. This briefing puts such problems in plain language. We summarise how to think through two questions with critical implications for future generations:

1. How much should we pay now, to avert future costs?
2. How should we pay – mainly through carbon pricing, or through borrowing?

We highlight three important things to think about, with respect to both questions:

1. Ethical attitudes to future generations
2. Attitudes to inequality and risk – how do we feel about these things?
3. Empirical considerations regarding future growth and risks – how likely are they?

These are complex questions. Our starting point for discussing them in the UK context is a key national policy document – the 2021 Treasury Net Zero Review. We look at what it assumes about these issues, and what this implies for Government policy. We find that policy must change significantly to match the Net Zero Review's rhetoric.

Background – HM Treasury's Net Zero Review

HM Treasury's Net Zero Review, published in October 2021, speaks to the issue of intergenerational fairness. Most importantly, it is the UK's first major attempt to grapple with paying for net zero, so it has an outsized bearing on the above questions. It also pays an unusual amount of attention to future generations, even containing a subsection on "intergenerational fairness".[1] The Treasury states that future generations matter just as much as we do; that climate change poses a severe risk, including to economic growth; and that the productivity gains from green technologies may be more limited or uncertain than assumed in the Government's more general Net Zero Strategy.[2]

On closer examination, however, this rhetoric may be part of a political struggle between No. 10 and HMT, with the latter aiming to keep borrowing down.[3][4] At the same time, HMT assumes that carbon pricing – and therefore spending on Net Zero – will remain low.[5] As we will see, these positions are contradictory: one cannot believe that borrowing should be kept low to benefit future generations, whilst not simultaneously stimulating much higher spending through alternative means – namely carbon pricing. It is to the issue of *how much* to pay that we first turn.

HOW MUCH TO PAY NOW?

The current UK policy landscape – a (very) brief introduction

Conventional discussions of how much to pay focus on the "discount rate". We need not dwell on precisely defining the discount rate (although technical detail is provided in Box 1). Suffice to say that it determines the optimal amount that should be spent today to avert future costs. A higher rate means that we "discount" the future more, and so should pay less now. Conversely, a lower rate implies we should pay more now, to mitigate costs in the future.

Things are slightly complicated in the UK policy arena, because discounting is no longer used in two critical areas of climate policy – target-setting, and "carbon valuation", defined as the value placed on a tonne of emissions reduction in any given year. Instead, UK climate targets are based on the scientific-precautionary approach enshrined in the Paris Agreement: namely that it is better to altogether avoid the extreme possible risks to future generations posed by climate change. This requires complete reduction to net zero by 2050.[6] The Department for Business, Energy and Industrial Strategy's (BEIS') carbon values are then back-cast from this climate target.[7] Nonetheless, these values exist simply for policy guidance: they are not yet reflected in the actual *price of carbon* which emerges from the UK's Emissions Trading Scheme (ETS) and drives the largest proportion of spending on UK emissions reductions (i.e. incentivised private-sector spending).[8] So it is worth examining whether we should be spending *more* on emissions reductions via the ETS, in order to hit our 2050 net zero target.

Moreover, the discount rate is still used in many UK climate policy areas. For example, when making a decision regarding the value of a given energy efficiency policy in (say) 2050, BEIS will multiply the expected tonnage of emissions reductions by the carbon value in 2050 – and then discount this figure using the discount rate.[9] The main policy on discounting is set out in HMT's Green Book.[10] The following section examines key considerations when thinking through these questions, what HMT's Net Zero Review assumes for each, and whether current UK policy matches its assumptions.

How much to pay – key considerations

Here we explore three critical considerations for determining how much to pay now to avert future costs – moral orientations towards the future; our feelings about inequality and risk; and empirical projections regarding both future economic growth and risks to that growth. Box 1 explains the technical reasons for our selection of these criteria; non-technical readers may skip this explanation without the argument losing clarity.

Moral attitudes to future generations

When considering how much to pay now to avert future risks, the first assumption we need to make is simple: how much do we value future generations? Do we regard their wellbeing as equal to our own? In other words, how far should we discount the value of some future unit of wellbeing, *just because* it occurs in the future?

Box 1: Key assumptions – a technical note

We focus on moral attitudes to future generations, attitudes towards inequality and risk, and assumptions regarding the future growth rate of the economy, because these three factors roughly correspond to the most important elements of the "discount formula" developed by Frank Ramsey. The Ramsey formula is the most widely-employed method of discounting, and (importantly) is also the approach employed by the UK Government's Green Book. We moreover believe that the above-outlined factors align very tightly with the most important assumptions regarding *how* to pay for climate change mitigation (i.e. through borrowing or carbon pricing), so we look at the same factors in the subsequent section on how to pay.

The Ramsey formula is quite simple. It goes as follows:

$$R = \rho + \eta g$$

In this equation, the discount rate (R) is produced by adding together two components, a "rate of pure time preference" (ρ) and a "wealth effect" (ηg). In simple terms, the "pure time preference" element (ρ) represents an ethical judgement about the value of future generations relative to those alive now – both given our moral ideas about whether we should value future generations less due to the simple fact that they will be alive many years from now, and given a more practical judgement about whether these future generations will actually exist at all given risk of human extinction (see the subsection "moral attitudes to future generations" for a clearer explanation of this element). The "wealth effect" (ηg) determines how much we should discount the future due to the fact that future generations may be richer (or poorer) than we are today. It is a combination of projections regarding future economic growth (g) and our degree of aversion to inequality across time (η). In more complex versions of the Ramsey equation, η can also represent our degree of aversion to inequality within a single generation and future *risk* – although this requires different formalisations, outlined in Box 2. Thus, we arrive at the three factors employed in this paper: ethical judgements about the future; feelings about inequality and risk; and assumptions about future growth.

According to the Ramsey formula, a high (low) rate of pure time preference leads to a higher (lower) discount rate. Forecasts of high (low) growth also lead to a higher (lower) discount rate, the effect of which is magnified by the degree of inequality or risk aversion η.

If we *do* discount future people's wellbeing just because it occurs in the future, some fairly bizarre implications follow. The most prominent of these is that the pain of an individual born earlier is valued as being worse than the pain of someone born later.

Deaths in the past (say, from 100 years ago) would also be valued as many, many times worse than present deaths, and present deaths as many times worse than future deaths.[11] Besides these issues, many philosophical traditions balk at discounting the future for its own sake. For example, Burkean conservative ideas of stewardship place equal emphasis on "those who are living, those who are dead, and those who are yet to be born".[12]

One of the few justifiable objections to such arguments is that our central obligation is to our "nearest and dearest" – meaning that their interests should take precedence over those of future generations.[13] Nonetheless, it is worth noting that this assumes a trade-off in climate change policy between the wellbeing of our nearest and dearest, and the wellbeing of everyone else. If we in fact believe that climate change threatens our nearest and dearest – for example, our own children – *as well as* everyone else, then there would still be a good case for spending lots now to avert these risks.[14]

Another possible objection centres around the risk of catastrophe from causes other than climate change, such as a nuclear war, an asteroid strike, and so on. If we believe with 100% certainty that a comet is going to wipe us all out in six months' time – as in the recent blockbuster *Don't Look Up* – then there is very little point in spending lots of money on climate change mitigation now, because future generations won't be around to reap the benefits. Of course, the real risk of human extinction in the foreseeable future is probably not 100%. The most eminent recent estimate, by Oxford philosopher Toby Ord, puts the risk at around 17% over the next 100 years not including climate change – translating into a probability (and corresponding discount rate input) of 0.2% each year.[15] This is a fair bit lower than the figure of 1% per year used in the Green Book discount rate formulas, although this is largely due to different definitions of the "risk" parameter: we need not dwell on this point here.[16]

In any case, current UK policy on the moral value of future generations is pretty contradictory. As we have seen, the Net Zero Review, with its emphasis on "intergenerational fairness", in principle values future people highly.[17] The Green Book, in contrast, suggests that we should "discount" future generations fairly substantially simply because they exist in the future.[18] This would imply spending less on climate mitigation today than under the Net Zero Review's assumptions.

Aversion to inequality and risk

Another key consideration is our general feeling about inequality and risk. Most important is how we feel about inequality in consumption between the generations. Note that this is not the same thing as how much we *value* future generations: believing that someone is your moral equal does not automatically imply that they are entitled to the same level of consumption as yourself.

Again, whether or not you do believe this depends on your moral assumptions. On the one hand, we might argue on meritocratic grounds that talent, hard work and so forth are evenly distributed across the generations, so it's unfair for one generation to have significantly higher consumption than another.[19] On the other, it's unclear why equality of consumption should be the aim – rather than equality of well-being, opportunity, dignity, or some other "good". Future generations may have higher well-being than us

at lower levels of consumption: it's not clear that they would anxiously compare their consumption levels to those of long-dead generations.[20] [21]

Before jumping to conclusions based on our own beliefs, it's worth sounding a note of caution. Because what these assumptions mean for *how much* we pay depends upon their interaction with another factor: the likely wealth of future people (explored below). If we expect future generations to be wealthier than ourselves, then a strong aversion to all forms of intergenerational inequality would in fact imply making future generations pay some of the costs of net zero – in order not to leave our generation worse off than them! On the other hand, if we think future generations will be poorer than ourselves, then high inequality aversion would mean spending *more* now.[22]

Nonetheless, a little-considered possibility in this rather abstract academic debate is that most people tend to be fairly enthusiastic about future generations being better-off than us, but fairly averse to them being poorer. This is evident in the widely-held belief that our children have a right to better opportunities and lives than those we ourselves have enjoyed.[23] In this case, we should spend much more on climate change mitigation now, even if future generations will be richer than us.

Two other kinds of aversion are also important. The first is our aversion to inequality in consumption within a single generation. This is particularly important when we consider that a large proportion of any given future generation will live in poorer countries, which will be more likely to experience the damaging effects of climate change. A higher degree of aversion to inequality within any given generations would mean attaching more value to these poorer people's consumption levels, and therefore paying more now to avoid climate-related hits to their consumption.[24]

Our aversion to risk and uncertainty is also critical. Risk and uncertainty are basically synonymous where it comes to the discount rate: essentially, "risk" refers to the likelihood that our projected future economic growth rates *may be wrong.* If we are highly risk-averse, then this uncertainty will scare us, and we will favour stronger action now to mitigate any such uncertainties. The reverse holds for lower degrees of risk-aversion. Our actions will then depend upon a combination of our degree of risk-aversion with how high we believe the uncertainties to be (see below).

Current UK policy is ambiguous about all these questions. HMT's Green Book is completely neutral about inequality – both within the generations and between them. It uses a value of 1 to represent its aversion to intergenerational inequality, which essentially means that its feelings about such inequality make no difference at all to the discount rate. Meanwhile, inequality within the generations doesn't get a look-in. The Green Book does account for increasing risk and uncertainty in the long-run – lowering the discount rate progressively for time-periods longer than thirty years – but not for possible uncertainties in the growth rate over shorter periods. [25]

Meanwhile, HMT's Net Zero Review suggests a higher degree of "aversion" on average.[26] There is little mention of income inequality between the generations, so we can assume that the Treasury remains pretty neutral on this matter. However, the Net Zero Review does express quite a lot of concern about inequality (both national and international) *within* the present generation. [27] For example, it refers to the "common

but differentiated responsibilities" framework under the Paris Agreement (whereby richer nations bear the greater proportion of the responsibility for emissions reductions); and it extensively discusses the "distributional impacts" of the transition within the UK.[28] Finally, as discussed below, the Treasury is relatively pessimistic about the uncertainties associated with GDP growth even during the transition period.[29]

Likely future growth, risks and uncertainties

As we have already suggested, the likely wealth of future generations (compared to ourselves) is a key consideration when thinking through how much to pay now to avert future costs. By "wealth" we really refer to consumption levels, which are conventionally measured through GDP. Many models assume that future GDP growth will remain high for the coming generation, despite climate change mitigation and impacts. If so, we can justifiably continue to spread climate spending between ourselves and our children, who will be able to afford to take on some of the burden. If, on the other hand, growth is likely to become zero or negative – either as a result of climate change mitigation or the impacts of climate change – that would have drastic implications for policy. We may have to start spending far more on mitigation, very soon indeed.[30]

Once again, looking at average economic growth alone might not tell us enough. If we expect global growth to remain high, whilst also expecting poorer parts of the world to get even poorer due to climate change, then we should spend more now if we care about poorer people's consumption. It may also be worth dividing growth into different kinds of consumption. For example, if we expect certain public goods (e.g. stable weather conditions) to be destroyed by climate change, and these public goods cannot be substituted with higher consumption of other goods, then again we should pay *more* now even if we think that average future economic growth will be high.[31]

The flipside of our assumptions about growth are our assumptions about risk. If we think that the physical risks from climate change are either very serious or frighteningly uncertain, we would favour spending more now to account for the possibility that climate change will disrupt our expected growth rates. On the other hand, if you believe that climate change poses more moderate risks, then you would probably favour spending rather less than under the above assumptions.[32]

In our view, no one should claim certainty with respect to either future economic growth or future climatic risks. Especially concerning the more distant future, and the more extreme risks, we simply don't know.[33] [34] As uncertainty is (generally speaking) a reason for caution, this would justify the adoption of a more precautionary approach, meaning that we should discount the extreme risks and the long-term future less.[35] The Treasury already accounts for such uncertainty in the long-run, but is more optimistic about short-run growth (over the next thirty years).

The Net Zero Review is arguably more pessimistic. Whilst it states repeatedly that the Net Zero transition can support future economic growth, it believes there are limits here: any marginal productivity gains will eventually diminish; and in many areas, productivity gains are either unlikely or highly uncertain.[36] It also notes that climate change already poses a threat to economic growth.[37] Although it makes no quantitative projections factoring in such intuitions, this seems more cautious than the Green Book,

which assumes a positive future growth rate of 2% per year before 2050, without accounting for climate change separately in its analysis.[38] Whereas the Green Book would favour spreading the costs of climate change mitigation, the Net Zero Review and target suggest the need to spend more now.

Box 2: How to deal with risk and within-generation inequality – a technical note

You may have noticed that aversion to inequality *within* any given generation, as well as aversion to risk, have the opposite effect on the discount rate compared to aversion to inequality *across* generations, when we assume high future economic growth. If inequality within any single generation is high, and we dislike this, we will favour a lower discount rate even if growth is high – as that growth may be highly unevenly distributed. Similarly, if we dislike risk and uncertainty, then we will also favour a lower discount rate even if future growth is projected to be high – because there will be great uncertainty about growth the further we peer into the future. But if we dislike inequality *between* the generations, then we will favour a higher discount rate if future economic growth is likely to be high – because future generations being richer than ourselves is a form of intergenerational inequality, so future people should pay more than ourselves in this case.

In technical terms, this mismatch requires that we complicate the Ramsey equation (detailed in Box 1) a little. The term η in the simplified Ramsey equation really only captures aversion to inequality *between* the generations, and not aversion to inequality within a single generation or aversion to future risks. This is because of the above-outlined difficulty, where these different kinds of "aversion" push the discount rate in different directions. To 'deal' with this problem, the Ramsey equation just ignores the latter two kinds of aversion – a somewhat problematic simplification.

Firstly, the simplified Ramsey equation assumes away within-generational inequality by pre-supposing that income is entirely equally distributed in any given time-period.[39] This is clearly a pretty consequential assumption to make with respect to climate change, given the fact that the majority of CO^2 is emitted by rich countries, while those who stand to be worst affected live in far poorer countries.

To address this problem, Johannes Emmerling et al. offer a framework that accounts for inequality within generations.[40] They relax the assumption of evenly distributed income to show that a high preference against within-generational inequality reduces the discount rate when per-capita income grows faster than median income:

$$R = \rho + \eta g^{pc} + \eta^2 (g^{med} - g^{pc})$$

Here the term $\eta^2(g^{med} - g^{pc})$ represents an inequality adjustment to the discount rate. The idea is that if income inequality is growing, per capita income will grow faster than median income. If this happens in a society which is averse to inequality, any positive impact that such growth would ordinarily have on the discount rate should be reduced, causing the discount rate to fall. This reflects the common-sense intuition that if we are against inequality within any given generation we should spend more on climate change mitigation now.

Secondly, the Ramsey equation does not allow for uncertainty in future economic growth rates (for example, due to climate change), meaning it cannot capture risk aversion. "Risk" here really means our approach to *uncertainty* in forecasts of the future, whether in terms of material wealth or more difficult-to-measure aspects like suffering.[41] Societies that are highly risk averse are likely to be in favour of lower discount rates when faced with an uncertain future, reflecting a "precautionary principle". Christian Gollier accounts for macroeconomic risk through including a term for the variability of growth projections, as below.[42]

$$R = \rho + \eta\bar{g} - \frac{1}{2}\eta^2.Var(g)$$

Here $\bar{g}$ represents the forecast mean growth rate and $Var(g)$ its variance. The $-\frac{1}{2}\eta^2.Var(g)$ term is a risk adjustment to the discount rate that reflects the precautionary principle. If projections over future growth are highly uncertain, the variance of the forecast *Var(g)* will be high, meaning that in a society which dislikes risk and uncertainty, any positive effect that growth would ordinarily have on the discount rate will be reduced. This reflects the common-sense intuition that if we are very cautious about risk and uncertainty, we should be investing more now to mitigate climate change.

Policy options

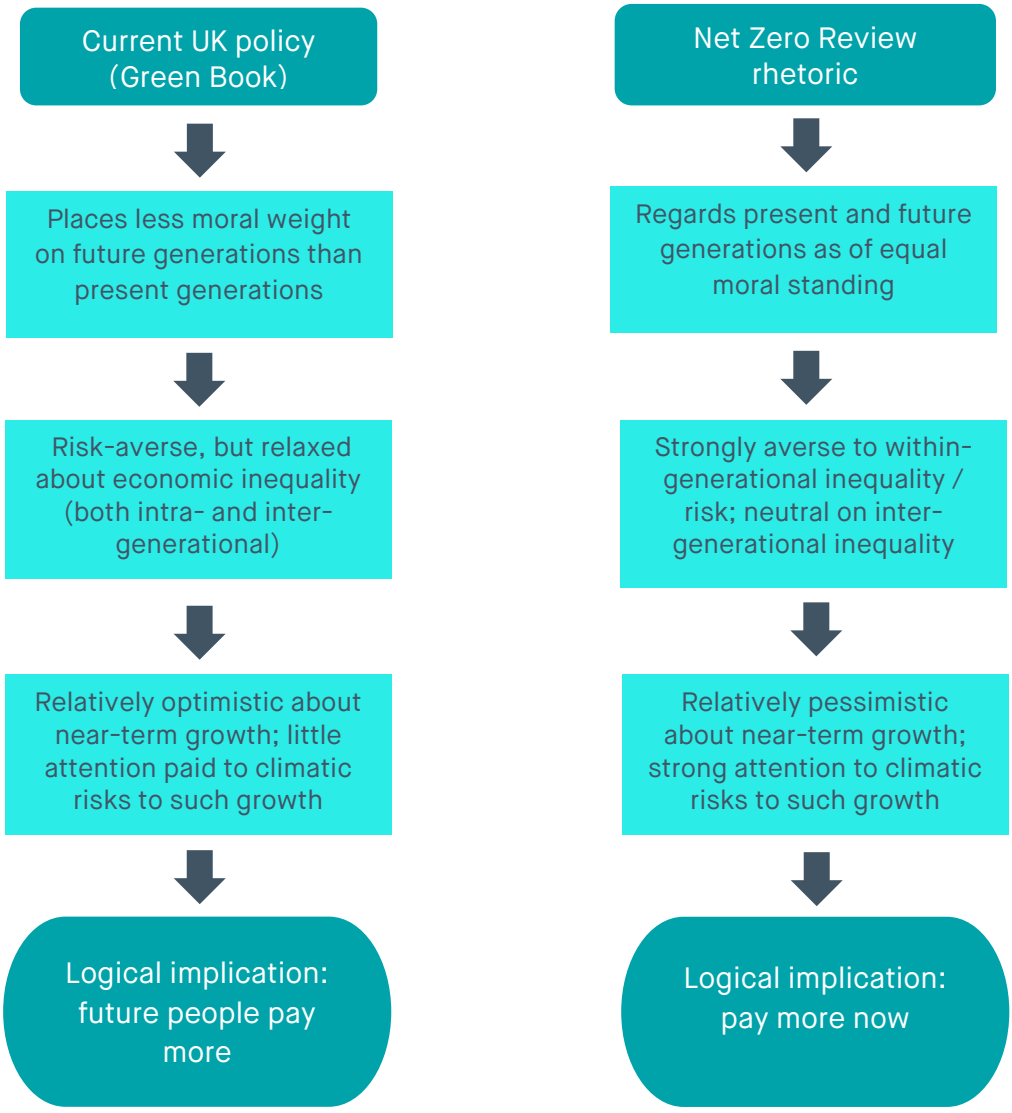
Our lodestar is the set of assumptions made in the Net Zero Review. It focuses more explicitly on paying for net zero than any other document (including the Green Book). As we have seen, the Review: places a high value on future generations; is pretty neutral about inter-generational inequality but averse to within-generation inequality and risk; and is relatively pessimistic about our future economic growth rates.

In terms of our emissions targets, the implication of these assumptions is almost too obvious to be worth stating: we must hit net zero, a precautionary measure which will avoid the worst risks to future generations. A less obvious inference is that the effective price placed on emitting greenhouse gases – whether through carbon taxation, the ETS, or regulation – must reflect this target. If the Net Zero Review's assumptions are correct, we simply cannot afford complacency from the perspective of future people: we must spend more now. The Review in fact ignores this implication,

but our policy recommendations draw out the gaps between its rhetoric and current policy, as well as the actions that the Treasury can take to close this gap.

The Net Zero Review's assumptions also logically imply that we should lower the discount rate, again meaning that we should spend more now. In terms of the weight it places on the moral value of future generations, the Net Zero Review is much closer to a previous "review" – the 2006 Stern Review on the economics of climate change – than it is to existing UK policy as embodied in the Green Book.[43] Compared to the Green Book, Stern adopted a much stronger moral attitude to future generations (namely the view that they have equal moral value), leading him to a lower discount rate.[44] [45] Moreover, while the Net Zero Review is arguably similar to both Stern and the Green Book in its neutrality towards intergenerational inequality of income, it exhibits a greater degree of aversion to inequality within a single generation, and is arguably more pessimistic about near-term growth and risks to such growth. All of these things would imply a lower discount rate, implying that we should spend more now to avert future costs.

Figure 1: Alternative policy options regarding how much to pay



Source: SMF

HOW TO PAY – CARBON PRICING OR BORROWING?

An even briefer introduction

Another important question when thinking about net zero and future generations is whether to pay through carbon pricing or borrowing. Carbon pricing involves putting a price on carbon emissions, either directly through taxation or indirectly through setting quantity limits on emissions then letting companies bid for emissions allowances in the open market, as in the UK ETS. Borrowing involves the government taking out loans to pay for mitigation, which are then paid back (largely) by future people. The matter of how to pay is secondary to the above question of *how much* to pay: from the perspective of future generations, our first obligation is to spend enough to prevent dangerous climate change. The important assumptions are also very similar to those regarding how much to pay. Nonetheless, how we pay is by no means neutral from the perspective of future people: here we will bring out why this is so.

How to pay – key considerations

Moral attitudes to future generations

Once again, our moral approaches to future people are critical when deciding whether to pay via taxation or borrowing.

A crucial consideration here is fairness. Some would argue that it is perfectly fair for current generations to pay for climate change mitigation through borrowing, and then to get future generations to "pick up the bill", as future generations are the main beneficiaries of action to mitigate climate change.[46] Others would maintain that future generations are only beneficiaries in the very limited sense that they are better off than they would have been in the most extreme climate change scenarios – a pretty low baseline. In this definition, we could claim that future generations 'benefit' even if our mitigation actions leave them economically far worse off than ourselves. [47]

Moreover, many argue that borrowing from the future to pay for net zero clearly violates the "polluter pays" principle – the notion that those who caused the mess should pay for cleaning it up.[48] Borrowing from the future essentially makes the "polluted pay" instead.[49] Under such circumstances, future generations would in effect be paying today's generation to mitigate the costs of climate change – despite the fact that we ourselves are (to a large extent) the cause of said climate change. [50] Worst of all, future generations are made to pay in this situation precisely because they are vulnerable to climate change, making borrowing in effect a "vulnerable pays" policy.[51]

Some take this argument too far, arguing that borrowing from the future constitutes a mafia-style form of extortion – i.e. asking future generations for money in return for not harming them.[52] This misreads the intentions of those promoting borrowing: in reality no one is threatening anyone.[53] Instead, most people who argue for borrowing do so on the basis that this is a moral necessity from the perspective of future generations – namely through an argument about *consequences.*

The argument about consequences runs as follows. Climate change mitigation is urgent from the perspective of future people, but current generations will not accept

the costs associated with climate change mitigation. Borrowing effectively passes the costs to future generations, avoiding this problem. If we do not borrow, the argument goes, we will do nothing, and the consequences for future people will be dreadful. [54] Nonetheless, this argument relies on the idea that borrowing is in effect a cost-free way of transitioning to net zero. As we will see, this (once again) depends on our assumptions about what the transition itself will do to economic growth, as well as on the composition of that growth.[55]

Aversion to inequality

Our feelings about inequality will also help to determine whether we will prefer carbon pricing or borrowing. In particular, our feelings about intergenerational inequality of consumption once again play a central role. Again, however, what precisely this means for the question of how to pay, frequently depends upon our assumptions about the likely wealth of future people (see the next subsection).

If we really dislike intergenerational inequality, but we also believe that future generations will be richer than ourselves, then it may well make sense to pay for the net zero transition by borrowing from future people, who will be more able to afford it than us. Under such a scenario, getting the present generation to pay would make us even worse off relative to future people, increasing intergenerational inequality.[56] On the other hand, if we believe that future generations will be poorer than us, then we will favour carbon pricing, which will hit the present generation rather than future people.[57] Finally, if we're relatively indifferent to inequality between the generations, we will always favour borrowing, even if it makes future people poorer than ourselves.[58]

Once again, though, ordinary people may hold none of these views. Instead, they may think that it's fine – or even very desirable – for future generations (for instance, our children) to be richer than us, but bad if they're poorer. In this case, we will always favour pricing over borrowing, even if future generations are richer than we are.[59]

Our feelings about inequality within the present generation are also important. Some would argue that government spending, via borrowing, has less of an impact on poorer households than higher carbon prices, which would be "passed on" to consumers in the form of higher energy bills and prices.[60] Although carbon pricing would eventually incentivise a shift towards lower-cost green alternatives, there would probably be a cost in the interim, from which vulnerable families must be shielded. Government could do so through redistributing the proceeds of carbon pricing, through shorter-term borrowing to support living costs, or through broader measures to tackle inequality. The Net Zero Review recognises this, arguing that "[t]here is a role for the government to mitigate some of the distributional implications of a 'polluter pays' model of decarbonisation", although more specific policies from HMT would be welcome here.[61]

Likely future growth

As we've seen, assumptions about growth feed into various aspects of the "how to pay" question. In particular, if mitigating climate change is likely to lead to a fall in the rate of economic growth, then one of the key arguments encountered above – that borrowing will enable us to have a 'cost-free' climate transition – doesn't hold so much

water. Under such a scenario, present generations would *already* be paying a cost from lower economic growth, so borrowing wouldn't necessarily incentivise them to "take on" climate mitigation.[62] Of course, we could compensate them for this loss through further borrowing, but if economic growth was likely to be low anyway, then future generations may simply not be able to bear the cost of servicing that debt.[63]

This problem is compounded by the fact that climate change mitigation may entail strong changes in the *composition* of economic growth. For example, even if we still managed to deliver economic growth whilst switching to an entirely plant-based diet, people's preferences may be strongly for meat-based diet, so this increase in GDP may not satisfy them: they may demand even more – possibly even far more – income to compensate them for their lower preference-satisfaction.[64] If this desired income transfer is sufficiently large, future generations may not be able to afford it, making the "cost-free" argument incorrect: someone has to take a hit here.[65] (Of course, this example assumes that people's preferences are fixed across time, whereas they may well be far more flexible – in which case the argument in favour of borrowing potentially holds more water). Moreover, current generations may see spending borrowed money on climate change mitigation, as opposed to some other public good like better schools or hospitals for people alive today, as a missed opportunity.[66] This is not to say that there is an alternative cost-free approach to climate change mitigation which would work better: climate change mitigation may simply *be costly*. In this case, borrowing is no less costly than carbon pricing – and more intergenerationally unfair.

Some have argued that we could fund borrowing via a form of quantitative easing. In this scenario, HMT would issue public debt to pay for the transition, which the Bank of England would then purchase (probably indirectly, on the open market). Nonetheless, this argument rests upon the idea that the borrowing would "pay for itself" by leading to increased consumption growth and therefore tax receipts, yielding no net loss for the state. This argument holds if climate mitigation is likely to entail increased growth, but folds if it is not.[67]

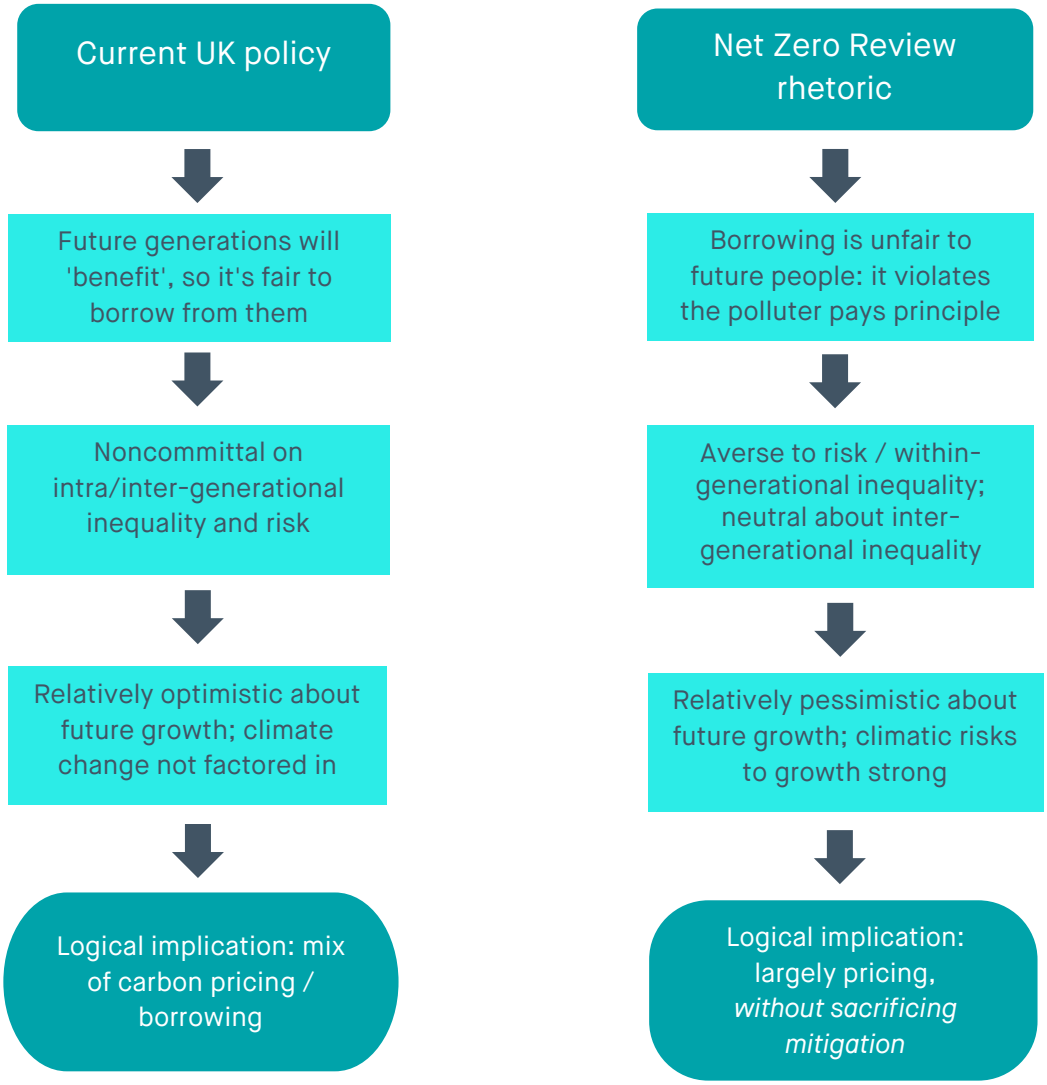
A similar point stands for the argument that lower interest rates will make borrowing for net zero investment much easier. Whilst – as long as interest rates remain low – this is undoubtedly true, it does not by itself eliminate the issue of intergenerational unfairness, because later generations will have to pay the principal back on the loan, as well as the interest. If future growth is high, then they will be able to afford this; if growth is low or negative, they may be left worse-off than ourselves.

Policy options

The Net Zero Review adopts the position that borrowing from future generations to pay for net zero is unfair, as it violates the "polluter pays" principle.[68] Moreover, the Review is relatively sceptical about the possibility that future economic growth will "pay back" any borrowed money.[69] As we have seen, these are both legitimate reasons – although we should stress that it is *not* legitimate to use them as an excuse for spending less on climate change mitigation. If the Review's assumptions about future generations hold, then, as the previous section demonstrated, spending should in fact be much higher: it should just be paid for mainly through carbon pricing rather than borrowing.

Current UK policy in this field is mixed. The Government extolls pricing, but in reality carbon prices are not high enough, as we shall argue shortly. Meanwhile, HM Treasury's "Green Gilt" scheme – a means of borrowing money for mitigation projects via issuing earmarked government gilts – is rather confused. For example, the second Green Gilt has a maturity date of 2053, the longest maturity for a bond of its kind in the world.[70] HM Treasury argues that this "reflect[s…] the UK's *long-term* commitment to reach Net Zero".[71] In other words, because net zero is a long-term goal, people living in the longer-term future should bear the costs. This is, of course, rather inconsistent with the assumptions of the Net Zero Review.

Figure 2: Alternative policy options regarding how to pay



Source: SMF

POLICY RECOMMENDATIONS

Rather than hoping to impose our own views on Government, in this paper we have sought to draw out the assumptions underpinning HM Treasury's Net Zero Review, and what those assumptions imply for future generations if taken to their logical conclusion. If the UK Treasury really does value future generations as much as our own, if it is indeed worried about the risks from climate change, and if it is reasonably sceptical about the possibility for high economic growth in the face of this, then some (conditional) recommendations follow. These can be summarised as, most importantly:

- Pay much more now
- Pay mainly via carbon pricing, rather than borrowing

The following section outlines the specific policies we think Government should institute to achieve this.

1. Lower the discount rate, and update the methodology used to calculate it

As previously noted, although the discount rate is (rightly) not used while setting the UK's longer-range climate targets and carbon price, it is still used in many other areas of UK climate policy. Cost-benefit analyses of climate-related public investments and regulations – for example, energy efficiency schemes – will employ the discount rate. We should emphasize that this does *not* influence whether the UK hits its 2050 net zero target. However, it does influence how we spread the cost of hitting that target between generations that are alive before 2050 – in other words, whether we should spend more now or defer a significant proportion of spending until future decades.

Starting from the assumptions of the Net Zero Review, it follows that we should reduce the discount rate, suggesting that we should be spending more now. As previously noted, the Net Zero Review's assumptions on the moral value of future generations are somewhat similar to those made in the 2006 Stern Review on the economics of climate change.[72] Just as the Net Zero Review claims to do, Stern regarded future generations as equally worthy of moral consideration as present generations. He therefore discounted their moral value at the minimum possible level (0%). The Green Book, by contrast, implicitly discounts the moral value of future generations at 0.5% per year in its standard discount formulas.[73] HMT does have an option for this value to sit at 0%, but this is not the default: we believe that it should be. Figure 4 shows the difference between the Treasury's current default discount rate and that recommended alternative. All in all therefore, the default discount rate should fall by at least 0.5%.

Figure 3: Current UK discount rates compared to those suggested by Stern (2007)

Period of years	0-30	31-75	76-125	125-200	201-300	300+
Default rate	3.5%	3.0%	2.5%	2.0%	1.5%	1.0%
Reduced rate (recommended)	3.0%	2.57%	2.14%	1.71%	1.29%	0.86%

Source: HM Treasury - "Intergenerational wealth transfers and social discounting"

We say "at least" because we also think that the discount rate *formula* should be updated to incorporate greater aversion to *within*-generation inequality and risk. Compared to both Stern and the Green Book, the Net Zero Review expresses a strong degree of concern about income inequality within a single generation (both globally and within the UK). It is also highly risk-averse, and cites concerns about uncertainties in the growth rate within the coming generation arising from both the technologies employed in the green transition and climate change itself. Overall, we therefore believe that the discount rate should be calculated using the alternative formulas introduced in Box 2, accounting for both within-generation inequality and risk/uncertainty. Due to the presently high maldistribution of resources across the globe and growing risks from climate change along with a darkening economic outlook, we think that this would lead to an even lower discount rate than proposed by Stern. As at present, the discount rate would also fall over time, accounting for greater uncertainty in economic growth the further we peer into the future.

2. Ensure that the UK ETS is strengthened to achieve a truly "Net Zero-consistent" price trajectory

Here we examine the huge swathe of UK policy where the discount rate is *not* (and should not be) used: carbon pricing. Under the Net Zero Review's assumptions, it is essential that we hit our 2050 net zero target, in order to avoid unacceptable risks to future generations. The target is determined through scientific-precautionary advice based on the Paris Agreement, and is moreover enshrined in UK law. Existing Government policy is correct in this regard: under no circumstances should the discount rate be applied to UK climate targets. Nor, it follows, should discounting be used when determining the carbon-pricing regime which we follow to hit this target.

But what should this carbon-pricing regime look like? It is clear that current carbon prices are not up to the job: under present arrangements it is unlikely that the UK will hit the 2050 target.[74] The Government recognises this, and in March 2022 published its plan to develop the UK Emissions Trading Scheme (ETS) in line with a "Net-Zero consistent" pathway by 2024 – a welcome development.[75]

When the Government's carbon pricing regime is finalised and instituted, how can policymakers tell whether we are actually on track to hit our net zero target? One easy-to-interpret proxy would be looking at the carbon price itself. In a perfectly efficient economy where carbon pricing represented the only form of climate change regulation, the price of carbon would exactly match the "carbon values" produced by the Department for Business, Energy and Industrial Strategy.[76] These represent the

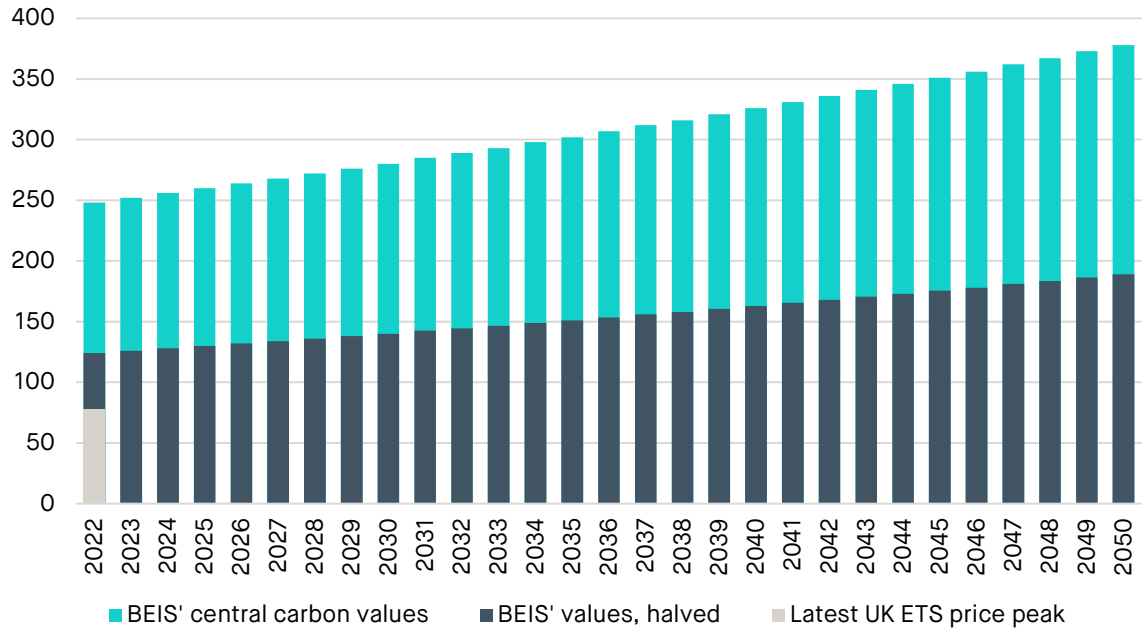
value placed on one tonne of emissions reduction in a given year, and are directly back-cast from the 2050 target.[77] A carbon price exactly matching these values was recommended in a 2019 report to the independent UK Climate Change Committee by Vivid Economics, and a 2021 report by the think-tank Bright Blue – both of which noted that the revised net zero target would greatly increase BEIS' carbon values and thus the ideal carbon price.[78] [79] Indeed, BEIS' carbon values are now very large indeed: nearly £250 per tonne of CO^2 equivalent ("/tCO^2e") in 2022, far higher than current UK ETS prices.[80]

Of course, we do not live in an idealised, perfectly efficient economy – meaning that BEIS' values represent the strong upper limit for any carbon price. In reality, carbon pricing will not be the most appropriate policy in many sectors: efficiency regulations, for example, may work much better in many industries. (These are the kinds of policies covered by the discount rate, which needs separate policy reform – see above). These measures would cover a large chunk of BEIS' carbon values, which therefore only represent the upper bound for the UK ETS price. Nonetheless, even if we are reasonably conservative and say that carbon pricing should cover only *half* of BEIS' overall carbon values – the approach adopted by the Office for Budget Responsibility in 2021 – this would still yield much higher carbon prices in the hundreds of pounds, around £125/tCO^2e in 2022 to be precise (BEIS' above £250 figure divided by 2).[81] It goes without saying that in this scenario, regulations in other sectors would have to be significantly strengthened to cover the other 50% of BEIS's carbon values.

All in all therefore, a net zero consistent carbon price for the UK ETS could sit somewhere between this lower limit (half of BEIS values) and the upper limit (BEIS's values) – probably much closer to the former at first, but still much higher than the current carbon price. Figure 4 compares these different prices. The suggested price trajectory is merely meant to provide guidance for policymakers who want a simple lodestar against which to measure the UK ETS price: it is not intended to be prescriptive. The actual UK ETS price results from interactions between the overall UK ETS "cap" and market forces of supply and demand, and our values may fail to capture the true net zero-consistent carbon price for the UK ETS. Our point here is simply to suggest that if the UK ETS price does not evolve in the above direction in the coming decade, this is a sign either that BEIS' carbon values are indeed wrong and need revisiting, or that the UK ETS may not be strong enough and needs further extension.[82]

We are presently in the middle of an energy crisis, and it would not be appropriate to suddenly ramp up carbon pricing when many vulnerable consumers are already facing significant hikes in their energy bills. Instead, the Government should aim to more gradually approach the net zero consistent trajectory until 2024, when pricing will be ramped up. The latter stage will shift the UK economy away from fossil fuels more quickly than under present policy, hopefully de-coupling average energy prices from (volatile) gas prices and thus *reducing* costs for the consumer.[83]

Figure 4: A possible net-zero-consistent carbon price, compared to current highs



Source: SMF analysis of BEIS data

3. Use higher carbon pricing to substitute for borrowing from the future

Expanded carbon pricing would also help to pay for our secondary idealised policy from the perspective of future generations – avoiding over-reliance on borrowing whilst not compromising spending on net zero.

In the Net Zero Review, HMT expresses concern that UK carbon pricing revenues will not be sufficient to compensate for the loss of tax receipts arising from the transition (most notably from the decline in motor traffic and associated taxation).[84] The Social Market Foundation has argued elsewhere that expanded road pricing – effectively a form of carbon taxation – could more than compensate for this loss.[85] Nonetheless, a key problem in HM Treasury's analysis is that it assumes a very low overall carbon price – around £50/tCO^{2}e in 2030. This is incredibly slight even by current standards, and clocks in only a little over a third of our projected minimum for a net zero-consistent carbon price in 2030 (£140).

Under the projected carbon pricing regime, receipts from carbon taxation – along with road pricing – would enable HM Treasury to recoup more of the revenue lost in the transition to net zero. In such a scenario, HM Treasury would not have to borrow huge sums of additional money to make up for the shortfall in tax revenues. Most importantly, it would not have to sacrifice climate mitigation in the process, which is far more critical from the perspective of future generations.

Of course, we are not arguing that borrowing should play no role in the net zero transition. For higher-risk spending that carbon pricing cannot stimulate, such as research and development (R&D) expenditure or the rollout of critical infrastructure projects, government borrowing will be absolutely necessary.[86]

Our suggested stronger carbon pricing regime actually complements this approach, by providing HMT with the fiscal headroom required to undertake borrowing for such purposes.

ENDNOTES

[1] Her Majesty's Treasury. 2021a. Net Zero Review: Analysis Exploring the Key Issues. Published online: https://www.gov.uk/government/publications/net-zero-review-final-report. p. 92.

[2] Rutter, J. 2021. The Treasury Net Zero Review Only Offers Partial Answers. Institute for Government, 22 October. Published online: https://www.instituteforgovernment.org.uk/blog/treasury-net-zero-review.

[3] Mason, P. 2021. The Conservatives' Net-Zero Strategy Would Doom the Planet to Climate Chaos. The New Statesman, 20 October. Published online: https://www.newstatesman.com/comment/2021/10/the-conservatives-net-zero-strategy-would-doom-the-planet-to-climate-chaos.

[4] Rutter, J. 2021. *Op. Cit.*

[5] *Ibid.*

[6] Watkiss, P. and Hope C. 2011. Using the Social Cost of Carbon in Regulatory Deliberations. *WIREs Climate Change* 2(6): 886-901.

[7] Department for Business, Energy and Industrial Strategy. 2021a. Valuation of Greenhouse Gas Emissions: For Policy Appraisal and Evaluation. Published online: https://www.gov.uk/government/publications/valuing-greenhouse-gas-emissions-in-policy-appraisal/valuation-of-greenhouse-gas-emissions-for-policy-appraisal-and-evaluation.

[8] Department for Business, Energy and Industrial Strategy. 2021b. Valuation of Energy Use and Greenhouse Gas: Supplementary Guidance to the HM Treasury Green Book on Appraisal and Evaluation in Central Government. Published online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1024054/1.Valuation_of_energy_use_and_greenhouse_gas_emissions_for_appraisal_CLEAN.pdf

[9] *Ibid.*

[10] Her Majesty's Treasury. 2022. The Green Book (2022). Published online: https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent/the-green-book-2020. Last accessed 30 March 2022.

[11] Greaves, H. 2017. Discounting for Public Policy: A Survey. *Economics and Philosophy* 33(3): 391-439.

[12] Burke, E. 1968 [1790]. *Reflections on the Revolution in France*. London: Penguin. pp. 194-5.

[13] Stern, N. 2010. *A Blueprint for a Safer Planet: How We Can Save the World and Create Prosperity.* London: Vintage.

[14] *Ibid.*

[15] Jevons, D. 2020. A Formula for Success: Reviewing the Social Discount Rate. Oxera, 30 September. Published online: https://www.oxera.com/insights/agenda/articles/a-formula-for-success-reviewing-the-social-discount-rate/. Last accessed 12 April 2022.

[16] Jevons, D. 2020. A Formula for Success: Reviewing the Social Discount Rate. Oxera, 30 September. Published online: https://www.oxera.com/insights/agenda/articles/a-formula-for-success-reviewing-the-social-discount-rate/. Last accessed 12 April 2022.

[17] Her Majesty's Treasury. 2021a. *Op. Cit.*

[18] Her Majesty's Treasury. 2022. *Op. Cit.*

[19] Dasgupta, P. 2008. Discounting Climate Change. *Journal of Risk and Uncertainty* 37(2-3): 141-169.

[20] Hayner, M. and Weisbach, D. 2016. Two Theories of Responsibility for Past Emissions of Carbon Dioxide. Public Law and Legal Theory Working Paper No. 582. Published online: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2783390.

[21] Greaves, H. 2017. *Op. Cit.*

[22] Dasgupta, P. 2008. *Op. Cit.*

[23] Gardiner, S.M. 2017. The Threat of Intergenerational Extortion: On the Temptation to Become the Climate Mafia, Masquerading as an Intergenerational Robin Hood. *Canadian Journal of Philosophy* 47(2-3): 368-394.

[24] Greaves, H. 2017. *Op. Cit.*

[25] Her Majesty's Treasury. 2022. *Op. Cit.*

[26] Her Majesty's Treasury. 2021a. *Op. Cit.*

[27] *Ibid.*

[28] *Ibid.*

[29] *Ibid.*

[30] Stern, N. and Stiglitz, J.E. 2021. The Social Cost of Carbon, Risk, Distribution, Market Failures: An Alternative Approach. Published online: https://files.static-nzz.ch/2021/4/26/7e32b21f-81b9-4033-907c-7aaeba85e7a5.pdf

[31] Caney, S. 2014. Climate Change, Intergenerational Equity and the Social Discount Rate. *Politics, Philosophy and Economics* 13(4): 320-342.

[32] Stern, N. and Stiglitz, J.E. 2021. *Op. Cit.*

[33] Ord, T. 2020. *The Precipice: Existential Risk and the Future of Humanity.* London: Bloomsbury.

[34] Greaves, H. 2017. *Op. Cit.*

[35] Weitzman, M.L. 2007. A Review of *The Stern Review on the Economics of Climate Change. Journal of Economic Literature* 45(3): 703-724.

[36] Rutter, J. 2021. *Op. Cit.*

[37] Her Majesty's Treasury. 2021a. *Op. Cit.*

[38] Her Majesty's Treasury. 2022. *Op. Cit.*

[39] Hilary Greaves, 'DISCOUNTING FOR PUBLIC POLICY: A SURVEY', Economics and Philosophy 33, no. 3 (November 2017): 391–439, https://doi.org/10.1017/S0266267117000062.

[40] Johannes Emmerling, Ben Groom, and Tanja Wettingfeld, 'Discounting and the Representative Median Agent', Economics Letters 161 (December 2017): 78–81, https://doi.org/10.1016/j.econlet.2017.09.031.

[41] Partha Dasgupta, 'Discounting Climate Change', Journal of Risk and Uncertainty 37, no. 2–3 (December 2008): 141–69, https://doi.org/10.1007/s11166-008-9049-6.

[42] Christian Gollier, Pricing the Planet's Future: The Economics of Discounting in an Uncertain World, 2013, 41-58, https://doi.org/10.23943/princeton/9780691148762.001.0001.

[43] Stern, N. 2006. *Stern Review: The Economics of Climate Change.* Published online: https://webarchive.nationalarchives.gov.uk/ukgwa/20100407172811/https:/www.hm-treasury.gov.uk/stern_review_report.htm

[44] *Ibid.*

[45] Her Majesty's Treasury. 2022. *Op. Cit.*

[46] Broom, J. and Foley, D.K. 2016. A World Climate Bank. In *Institutions for Future Generations*, eds. I. González-Ricoy and A. Gosseries. Oxford: Oxford University Press.

[47] Gardiner, S.M. 2017. *Op. Clt.*

[48] *Ibid.*

[49] *Ibid.*

[50] *Ibid.*

[51] *Ibid.*

[52] *Ibid.*

[53] Rendall, M. 2021. Public Debt and Intergenerational Ethics: How to Fund a Clean Technology 'Apollo Program'?. *Climate Policy* 21(7): 976-982.

[54] Broom, J. and Foley, D.K. 2016. *Op. Cit.*

[55] Maltais, A. 2015. Making Our Children Pay for Mitigation. In *The Ethics of Climate Governance*, eds. A. Maltais and C. McKinnon. London: Rowman and Littlefield.

[56] Caney, S. 2014. *Op. Cit.*

[57] *Ibid.*

[58] *Ibid.*

[59] Gardiner, S.M. 2017. *Op. Cit.*

[60] Lockwood, M. 2013. Paying for Climate Policy: The Case for Long-Term Public Borrowing. IPPR Progressive Review, 26th November. Published online: https://www.ippr.org/public/juncture-item/paying-for-climate-policy-the-case-for-long-term-public-borrowing

[61] Her Majesty's Treasury. 2021a. *Op. Cit.*

[62] Lawlor, R. 2016. The Absurdity of Economists' Sacrifice-Free Solutions to Climate Change. *Ethics, Policy and Environment* 19(3): 350-365.

[63] *Ibid.*

[64] Maltais, A. 2015. *Op. Cit.*

[65] *Ibid.*

[66] *Ibid.*

[67] Helm, D. 2020. The Environmental Impacts of the Coronavirus. Environmental Resource Economics 76(1). Published online: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7204192/

[68] Her Majesty's Treasury. 2021a. *Op. Cit.*

[69] *Ibid.*

[70] Her Majesty's Treasury. 2021b. Second UK Green Gilt Raises Further £6 billion for Green Projects. 21st October. Published online: https://www.gov.uk/government/news/second-uk-green-gilt-raises-further-6-billion-for-green-projects

[71] *Ibid.*

[72] Stern, N. 2006. *Op. Cit.*

[73] Her Majesty's Treasury. 2022. *Op. Cit.*

[74] House of Lords Industry and Regulators Committee. 2022. UK Will Miss Net Zero Target Without Urgent Action, Warns Lords Committee. 04 March. Published online: https://committees.parliament.uk/committee/517/industry-and-regulators-

committee/news/161468/uk-will-miss-net-zero-target-without-urgent-action-warns-lords-committee/.

[75] Department for Business, Energy and Industrial Strategy. 2022. *Developing the UK Emissions Trading Scheme (UK ETS).* Published online: https://www.gov.uk/government/consultations/developing-the-uk-emissions-trading-scheme-uk-ets.

[76] Department for Business, Energy and Industrial Strategy. 2021a. *Op. Cit.*

[77] *Ibid.*

[78] Vivid Economics. 2019. *The Future of Carbon Pricing in the UK: Report Prepared for the Committee on Climate Change.* Published online: https://www.theccc.org.uk/publication/the-future-of-carbon-pricing-in-the-uk-vivid-economics/

[79] Buckland, J. 2021. Green Money: A Plan to Reform Carbon Pricing in the UK. London: Bright Blue Campaign. Published online: http://www.brightblue.org.uk/wp-content/uploads/2021/07/Green-money.pdf.

[80] Department for Business, Energy and Industrial Strategy. 2021a. *Op. Cit.*

[81] Office for Budget Responsibility. 2021. Fiscal Risks Report – July 2021. Published online: https://obr.uk/frr/fiscal-risks-report-july-2021/.

[82] Thanks to Professor Simon Dietz of the London School of Economics for clarifying this point.

[83] Lord, T. 2022. What Goes Up Must Come Down? Tony Blair Institute for Global Change, 03 March. Published online: https://institute.global/policy/what-goes-must-come-down. Last accessed 14 April 2022.

[84] Her Majesty's Treasury. 2021a. *Op. Cit.*

[85] Corfe, S. 2021. Road to Ruin? Public Attitudes Towards Road Pricing as an Alternative to the Current Fuel Duty Regime. Social Market Foundation, 15 October. Published online: https://www.smf.co.uk/publications/road-to-ruin/.

[86] Rendall, M. 2021. *Op. Cit.*