Finite Resources and Future Generations

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Finite natural resources like oil, coal and natural gas, present a special difficulty for justice between the generations. Unlike other components of the natural world, sunlight or plant and animal stocks for example, the finite and non-renewable nature of such resources means that any exploitation by a generation permanently removes some of the initial stock from all future generations. And if the initial stock is small enough and the exploitation rapid enough eventually all, or at least all the economically usable portion, of a finite resource will be exhausted, and all generations past the exhaustion point would be deprived of the resource entirely. This is a problem because it would seem that by depleting (and eventually exhausting) finite stocks of natural resources, earlier generations do an injustice to later ones, who will be deprived of the resource.

The problem is real for us, as this is the situation we face with regard to carbon-based energy resources – in particular oil, coal and natural gas. Although the size of the initial stock and the size of the usable stock varies quite a bit between them, in each case our current rate of exploitation will exhaust the total stock within a few centuries at most, and in all likelihood quite a bit sooner than that, given that

consumption rates have been steadily increasing since we began exploiting these resources, and that population and economic trends indicate a vast increase in consumer demand on the horizon as poorer countries become richer.[1]

I don't intend to propose here a solution to this problem, that is, I don't propose an actual principle of distribution for exhaustible resources across generations. Rather I hope to root out and rectify what I think are errors in the initial framing assumptions that ground the sorts of solutions on offer in the literature, and propose a new framework on which to ask and answer these sorts of questions concerning the just distribution of finite resources across generations.

The traditional solution to this problem on the part both of economists and philosophers is to suggest that those generations who exploit exhaustible resources owe compensation to future generations, whom they deprive of the resource. Economists like John Hartwick (1977) propose that present generations save extra capital to pass on to future generations as payment for their (the future generations) loss of capital in the form of the resource.[2] Alternatively, philosopher Brian Barry has proposed that instead of capital, consuming generations owe future ones compensation in the form of the productive opportunities lost by the deprivation of the resource.[3]

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[1] For the purposes of this essay am setting aside issues of global climate change as a result of loading the atmosphere with carbon from the burning of hydrocarbon fuels. These issues will (we can only hope) constrain global consumption of hydrocarbon fuel, although there is always the possibility that a technological solution to the carbon emission problem will be found. But the issues of distributive justice between the generations I address here concern all such exhaustible resources, not just those that produce oxides of carbon when burnt (natural gas, for example) and so even if this prediction doesn't hold true for oil and coal, the problems are still worth considering.

[2] Hartwick, John "Intergenerational Equity and Investing the Rents from Exhaustible Resources" American Economic Review, Dec. 1977 (pp. 972-975).

[3] Barry, Brian, "Intergenerational Justice and Energy Policy" in *Energy and the Future* D, MacLean and P.G. Bown, eds. Rowman and Littlefield, 1983 (pp.15-30).

I think that these compensation solutions are mistaken, because I think they are solutions to a misconceived problem. And I think that once we correct the mistakes in the conception of the problem, compensation solutions won't be the whole story, although they might still play a role.

There are two misconceptions at the heart of both of the solutions outlined above. Both concern the nature of the claim that future generations have on the resource. The first one is that each generation has a claim to the entire initial stock or finite resources, and the second is that every generation has an equal claim to a given resource as every other generation. Let me address these two in turn.

Both Hartwick and Barry make the first assumption, which is that every future generation has a claim to the entire initial stock of the resource. Hartwick's proposal is for a mechanism to guarantee that the initial stock of resource, imagined as 'productive capital', is never lessened, by having those generations who dip into the resource replace the lost capital. This could only be thought to be mandated by justice if every generation had a claim to the entirety of the initial stake.[4] Barry is more explicit. He says ". . . [J]ustice requires us to compensate future generations for depleted resources, so they have as much productive potential as they would have inherited had the resource not been depleted."[5]

Once we make this assumption about the nature of the claims individual generations have on the resource stocks of the earth a compensation solution is inevitable, since any exploitation at all infringes on the claims of future generations. If every generation is owed every drop of oil that the first generation had available to it, then the only way to respect those claims compatible with any use by any generation is to compensate all future generations for their lost resources in some coin or other. And the amount of the compensation is also set by the assumption: since what justice demands is that each generation have their claim respected, and since those claims are to the entire initial stock, then what is

[4] Hartwick, pp. 972 & fn. 2.
[5] Barry, p. 22.

owed in compensation is the amount that was removed from the initial stock by the consumption of the earlier generation.

But why should we make this assumption? What reason is there to think that every generation has a claim to the entirety of the initial stock? For such an important premise, there is surprisingly little in the way of explicit argument available in the literature. Barry does offer an argument, one that I think is in fact the motive behind the assumption on the part of many. The argument is quick enough to quote in full:

> "The basic argument for an equal claim on natural resources is that none of the usual justifications for an unequal claim – special relationships arising in virtue of past service, promises, etc., applies here. From an atemporal perspective, no one generation has a better or worse claim than any other to enjoy the earth's resources. In the absence of any powerful argument to the contrary, there would seem to be a strong presumption in favour of arranging things so that, as far as possible, each generation faces the same range of opportunities with respect to natural resources."[6]

The problem with this argument is that when we understand the phrase 'range of opportunities' in the last sentence to mean that each generation has a claim to the entire initial stock of resources, as Barry does, then the premise provides insufficient support for the conclusion.

To see this, consider a toy case: Suppose we were to divide a pie between children. And suppose further that none of the children had any prior relationship to the pie that would give them a claim to a particular amount of it. None of them helped to make it, none were promised half of it, etc. In other words, no child has a better or worse claim to the pie than any other. What does each child have a claim to, in such a case?

[6] Barry, p. 21.

I think the obvious answer is: each child has a claim to an equal share of the pie. But by Barry's argument, it would seem that each child would have a claim to the *entire* pie. But that just seems implausible. Why would we infer from fact that the children had equal claims to the pie that they each had claims to the whole pie? The answer can't be that in the resources case present generations remove resources that future generations would otherwise have had, since the same is true of the children in the pie case. If Johnny has some pie, then that means that Jenny will have less than she would have had Johnny had none.

So I don't think the argument Barry offers from the equality of claims is successful. But absent that argument, we have no good reason to adopt the assumption.[7] Rather what I think the toy example shows is that we have a reason to think that each generation is owed an equal *share* of the initial stock of a finite resource.

But this doesn't seem to put us yet out of the reach of a compensation solution. Given the large (we hope) number of future generations, and the relatively small initial stock, the share each generation would be due would be too small to be of any use. Thus any useful consumption would still infringe on the claims of future generations, and as a result we would still have to resort to a compensation scheme. Such a scheme would have different targets than one set up to satisfy the larger claims of the earlier assumption, but it would be a compensation solution none the less.[8]

And here is where the second misconception plays its role. Recall that the second misconception was that every generation has the same claim to a resource as every other. This assumption is made explicitly in Barry's argument rendered above, and is implicit in Hartwick's discussion of the issue. And if

[7] In fact, Barry says as much in the next sentence: "I must confess that I can see no further positive argument to be made at this point." (Barry, p. 22).

[8] Note that even if the above argument were sound, and I don't think it is, it's still no reason to adopt the earlier assumption, that each generation is owed the entire stock.

we make this assumption then we are forced to a compensation solution, given the large number of future generations. But why make this assumption?

Again, Barry supplies us with the argument here – every generation has an equal claim to the resources because none of them have any special claim to them. But again, I think that the conclusion here is too strong. While it might be true that no special relationships exist between generations and pools of natural resources that would be reasons for an unequal distribution, that alone isn't enough to conclude that an equitable distribution is the only just one, because the norms of justice only apply to resources that have value to the potential recipients. And since not all generations will value oil (for example), not all generations will have a claim to a share of it – at least not a claim grounded in justice.

As evidence for the proposition that justice makes no demands on the distribution of valueless things, consider another toy case. Imagine I am given a set of small, unremarkable pebbles, and there are ten people in the room, each of whom has an equal claim to the pebbles in the same manner as before (i.e. none has a special relationship to the pebbles that would argue for an unequal distribution). But let us further stipulate that none of the people present has any use for, nor any desire for, any of the pebbles. Now, what do the norms of justice have to say about the proper distribution of the pebbles? If I give them out unequally, or not at all, have I wronged or harmed anyone? I think the answer to these questions is 'no', and that because I don't think that justice has anything at all to say about the distribution of valueless things.

And this stands to reason, as distributive justice is about arbitrating between competing claims, on the understanding that such arbitration is necessary because people have something at stake in their claims, and if those claims aren't vindicated, they stand to lose their stakes. If the things claimed are valueless, then people don't have anything at stake, and we don't feel the need to arbitrate to avoid unfair losses.

This reasoning might sound strange when applied to something like oil, which not only has great value to us in the present, but also seems like the sort of thing which will always have value, since it is a source of energy – which is of enduring value. But there are at least two reasons why a resource like oil might be valueless to a generation.

The first would be because the generation lacks the technology necessary to exploit it. For example, oil was valueless to our stone-age ancestors: They didn't even know it was there, and even if they did, they wouldn't have been able to get to it, and even if had they wouldn't have known how to refine it, and even if they could have done that, they didn't need refined oil for any purpose, or at least for any purpose that couldn't be served much better by other resources, such as wood. So in a straightforward way, the oil was valueless to them.

But another way that a resource can be valueless for the purposes of distributive justice is for it to be displaced by a superior competitor. A competitor for a resource is just another resource that has all (or many of) the same uses as the first resource. So, for example, consider again our cave men. Imagine that they have mastered the art of making fires and stone tools using flint rock. And imagine further that these functions are absolutely vital to their survival. Given this picture, we can assume that flint rock is a very valuable resource to the cave men, and as such the distribution of flint rock among them is subject to the demands of distributive justice. But given all this, what does justice have to say about their distributing some of that flint rock to us? Do we have any claim to the flint rock? Put it another way, if they used up all of the flint rock before we came on the scene, would they have wronged us?

The answer to all of these questions is, of course, 'no'. They don't owe us any flint rock, and they wouldn't have harmed us if they had used it all. But this can't be because flint rock isn't useful to start fires or make stone tools in our time. Flint rock retains all of its internal properties that made it useful to the cavemen. Rather, what happened was that we discovered vastly superior means of performing the

sorts of tasks the cave men used flint rock to perform, and as such it was displaced as a valuable resource to us, and we can no longer make claims on it from the grounds of distributive justice.

What the above considerations point to is a pattern of changing value, and thus changing demands of justice, for resources relative to the technological status of the potential recipient generation. As technology changes over time, different sorts of resources become exploitable, and thus valuable, and by the same token, different sorts of competitors for existing resources also become available.

And there seems to be at least one intuitive sort of pattern that seems likely to emerge, given what we know about the nature of change in technology (i.e. that it improves over time). That is a pattern wherein a resource is at one point valueless, because the generations at that stage can't exploit it; then it becomes valuable as the technology to exploit it comes on line, and then it loses its value as technology improves to allow the exploitation of superior competitor resources. The flint rock in the earlier example is something like this. We can imagine some time prior to figuring out how to chip flint rock into cutting tools etc. that the rock was valueless to he cave men living there. Then later, after the techniques were invented, the rocks were quite valuable to the cave men. And finally, much later, the rocks return to being valueless, as new and better techniques for starting fires and cutting material become available. We might call such resources 'window' resources, because they have a window of value, defined as the interval between the advent of the exploitation technology and the advent of superior competitors.

Now the application of this sort of pattern to oil as a resource should be obvious. Prior to the technology that made the refining and combustion of oil possible (as well as the technologies that made such a powerful, compact energy source desirable) oil is valueless to the generations that occupy the earth. Once the exploitation of oil becomes possible, then oil becomes valuable, as it is now. But when other technologies come on line that will outcompete oil for what it does (as an energy source, I'm ignoring,

for present purposes, other uses of oil) then oil will lose its value. In other words, oil is a window resource.

What this means for distributive justice is, if we take again our assumption that the demands of justice only apply when the potential recipient values the resource, that shares of resources aren't owed to generations for whom they have no value. And, in the case of 'window' resources, this means that shares are only owed to those inside the window of value. Those to the left of the window on time line, the cave men and others, aren't owed anything because the resource is valueless to them as they lack the ability to exploit it. Those to the right of the window on the time line, those in the fusion future, aren't owed anything because they don't need it, they have their fusion.

The upshot of all of this is that the proper framework for asking and answering questions about the just distribution of window resources like oil between generations is one where we first determine which generations fall inside the window of the resource, since only those generations will have a justice-based claim to the resource.

Now I haven't yet said anything about what the demands of justice actually are inside the window. That's because I am interested here in clearing up errors in the framing of the puzzle, rather than in the final solutions to it. What my arguments above show is that certain sorts of distributive options, like strict equality, are at least possible for window resources like oil, even though the resources are finite.

And this last point has some important implications for our policy choices with regards to the consumption of finite resources. Perhaps the most important one is that, if resources like oil are in fact equitably distributable between the generations inside the window, then we might have a justice-based reason to conserve stocks of oil, by lowering our consumption rate, in order not to take more than our share. Note that the compensation solutions to which I have been referring cannot give us such reasons,

as they assume that any share we take will be an infringement of the claims of future generations, and thus any consumption will have to be rectified by compensation. If we think that there is no way to equitably distribute the oil, so that any amount we take will have to be paid for, then there's no (justice-based) reason to take more or less of it.

In closing I want to address two further issues regarding the window. The first is the epistemic difficulties we might have in determining where the right edge of the window is for any given resource. To do so, we need to make guesses about what sorts of technologies might come about, and what those technologies might allow us to do in terms of exploiting different resources. And of course, guesses like this are going to be fraught with errors, as a result of the many ways in which we can go wrong. But is this epistemic uncertainty bad enough to render this analysis useless for the purpose I intend for it, i.e. to serve as the normative basis for decisions about resource distribution? I don't think so. But let me offer some reasons.

Firstly, let me note that we make guesses on the future path of technology all the time as it is. And not just idle speculation in sci-fi novels, but guesses on which we make bets of actual value. The most obvious example of this is investment in the research itself. When we invest in a research program, we bet the money we invest on the possibility that the research will produce technology that will be valuable. But of course, we don't bet the money blindly. Rather, we try and allocate our bets along the probabilities that a given research project will in fact pan out. Those probabilities we assign by making educated guesses about the viability of various possible future technologies.

Secondly, even if we can't forecast the leading edge of the window with very much accuracy it's still useful for our purposes. That's because what we need, first and foremost, is a solution to the problem of a very large number of recipient generations. More specifically, what we need is a way to put an upper bound on the number of generations in the distribution pool, one that allows a range of possible shares

that are large enough to be of value. And even if we can't tell the actual date of the window's closing to within a hundred years, or a thousand, we can with confidence say it won't be open forever, and what's more to the point, that it won't be open for long enough for the ratio of resource s to generational recipients to become too small. So I think for these reasons that the solution here is useful in spite of the epistemic uncertainty involved in guessing the end of the window period.

The second (and last) issue I want to address is the relationship between the activities of the generations inside the window, and the size of the window, for a given resource. Firstly, I should note that when a resource is exhausted then in some sense it becomes valueless for those generations that follow the depletion, since it isn't around for it to be of value. But if this is so, doesn't it mean that those generations that follow the exhaustion of a resource don't have any claim to it, because it's valueless to them? And since we determine (in part) when the resource is exhausted by our current consumption of it, doesn't this mean that we can increase the share we are due by increasing our consumption, thus bringing the leading edge of the window closer to us? But that can't be right, because it would mean that we could wind up owing less oil to future generations by using more oil now.

The above problem stems from an ambiguity in the use of the term 'valueless'. In the sense of 'being worth a certain amount', the missing oil is valueless to future generation, because there is no oil to be worth anything. But that is not the sense we mean when we restrict justice claims to things 'of value'. That latter sense of the term a thing of value is more like: 'something that the recipient could use, and would give them value if they did use'. In that sense, oil is still valuable to those that lack it, inside the window. Outside the window, of course, oil is valueless in the distributive justice sense, although it might still be worth something as an object to the members of the generation in question, past or future.

But what the above also shows is the possibility of a gap between the exhaustion of a window resource and the closing of the value window. If a window resource is also an exhaustible resource, as oil is, then it's possible for the early generations inside the window to over-consume the resource, such that it's exhausted before a replacement resource is available. In that scenario, the generations between the exhaustion date and the arrival of the new technology have had a claim violated; and every generation inside the window has a duty of justice to ensure that they do not cause some future generations to fall into the gap by over-consuming the resource.[9]

And this is perfectly consonant with our intuitions about whether and why it would be bad to use up all of the oil before another energy source is found: because the hardships faced by the immediately future generations would be our fault. But note that this sense of guilt doesn't intuitively extend outward towards those in the distant future. If we exhausted all the oil in this century, the hardships of the next would be on our consciences, but not the worry about having cheated the denizens of the Star Trek universe of their share of oil.

Another important aspect of the window view is that we have some measure of control over both the time-to-depletion and the leading edge of the window. We can move the exhaustion point nearer and farther by adjusting our consumption of the resource up and down. And we can (although more indirectly) move the arrival of the competitor technology back and forth, by investing more or less in the sorts of research endeavors that might bring it about. These two levers then give us some goodly measure of control over the creation of a gap. And this control, combined with the demands of justice towards those who might fall into the gap, gives us a powerful normative duty to insure that no gap is created, or to compensate those that might fall into it if it is created.

[9] And this is where a compensation scheme might have a role to play, in rectifying the (unjust) losses of future generations inside the window. Again, the actual targets of such a program would be determined by answers to prior questions about the size of the window, the amount of the initial stock and the principle of distribution.

And this last is the point I want to leave you with. Regardless of what the actual demands of distribution are inside the window, what the above shows is that we, as denizens of the oil window, have a special duty to avoid exhausting the oil resource before the window closes, i.e. before superior alternative energy sources are available. As such, I feel we should guide our decisions about resource use and distribution with reference to our best guesses as to the pertinent facts: how much oil remains? How long will it last at the current rate of consumption? When will the competitor resource technology likely appear? And finally: If the answer to the second question is later than the answer to the first, what shall we do to rectify the situation, and bring the replacement date inside the exhaustion forecast?

The metaphor that suggests itself is of a bridge – the exploitation of exhaustible window resources is like the building of a bridge, from one technology period to another. On the near bank, we have the onset of exploitation, on the far bank, we have the replacement by superior technology. What is needed is a bridge long enough to get safely to the other side. All of those who exploit the resource are engaged in building the bridge, and they will only have done so successfully if no crosser falls into the gap between the end of the bridge and the far bank.

The metaphor is appealing because of the aptness of the harm in building a bridge halfway across a river. Those who attempt to cross over such a bridge have a special complaint against the builders for the harm they suffer, since it's a harm that would have been entirely avoided if they hadn't been tempted to attempt the crossing by the appearance of the bridge, and the implicit promise inherent in such a structure, that it will render one safely across. Those generations after us who live in a society that needs oil but lacks it due to our overconsumption are like our unfortunate crossers, they suffer harms that are particularly the fault of the bridge builders, because they wouldn't have suffered them at all if it weren't for the actions of those earlier generations that put them on that path.