Moral uncertainty about population axiology

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Abstract:
Given the deep disagreement surrounding population axiology, one should remain uncertain about which theory is best. However, this uncertainty need not leave one neutral about which acts are better or worse. We show that as the number of lives at stake grows, the Expected Moral Value approach to axiological uncertainty systematically pushes one towards choosing the option preferred by the Total and Critical Level views, even if one's credence in those theories is low.

1. Introduction: Population ethics and moral uncertainty

Population ethics is the study of the unique ethical issues that arise when one's actions can change who will come into existence: for instance, actions that lead to additional people being born, fewer people being born, or different people being born. The most obvious cases are those of an individual deciding whether to have a child, or of society setting the social policies surrounding procreation. However, issues of population ethics come up much more widely than this. How bad is it if climate change reduces the planet's "carrying capacity"? How important is it to lower the risks of human extinction? How important is it, if at all, that humanity eventually seeks a future beyond the Earth, allowing a much greater population?

An important part of any sane ethical theory, consequentialist or otherwise, is its axiology: its ranking of states of affairs in terms of better and worse overall, or (if cardinal information is also present) its assignment of *values* to states of affairs. The two most famous approaches to population axiology are the Total and Average Views. The Total View says that the value of a state of affairs is the *sum* of the well-being of everyone in it — past, present, and future. The Average View instead holds that the value is the *average* lifetime well-being of everyone in it. These views agree when the size of the (timeless) population is fixed, but can disagree when comparing larger and smaller populations. Other things being equal, the Total View suggests that the continuation and expansion of humanity are extremely important, while according to the Average View, they are a matter of relative indifference.

In *Reasons and Persons* (Parfit (1984) Part IV, Chapter 17), Parfit showed that the Total View leads to a conclusion many find troubling (the 'Repugnant Conclusion'): that for any world with billions of very well off people, there is superior world with far more people who have lives of barely positive well-being.

Much of the history of population ethics since then has been an attempt to develop axiologies which avoid the Repugnant Conclusion. However, a series of impossibility theorems (Parfit (1984), Part IV, Chapter 19, Ng (1989), Carlson (1998), Arrhenius (2000); Arrhenius (Ch. 11, forthcoming) has shown that the only way to avoid this is to take on other counterintuitive implications, be they formal problems (like cyclic betterness orderings) or substantive problems (like preferring adding people

with negative well-being to adding people with positive well-being). In this situation, the reaction of any honest enquirer has to be one of *uncertainty* about population axiology.How, then, are we to decide what to do in the many domains where our actions may change the population?[1]

One approach would be to press on with the philosophical work, to better understand the available options, and to attempt to resolve the moral uncertainty. We certainly approve of this approach, but progress will not be instantaneous, and in many cases (such as climate change) immediate decisions are required: the question remains of how to decide what to do about these issues while we do still have uncertainty.

We could look more carefully at the real-world questions that concern us, and see if there is agreement between the theories we are considering. For example, we might note that since living standards have improved over the centuries, the Average View might not be indifferent to continued human existence after all. Even if living standards stopped improving now, additional generations at this level would continue to bring up the timeless average. In this way, we might be in a position of knowing which acts are better despite our uncertainty over the underlying evaluative theory (and hence over precisely *why* those acts are better than the alternatives). This scenario certainly simplifies matters when it arises, but not all of the practical questions we face have this convenient feature.

Our problem can be formalised into the question of *axiological uncertainty*: given a set of available options, and credences in each of a set of axiologies that disagree among themselves about the values of those options, how should one choose?

At least when one's relevant normative uncertainty is restricted to the domain of axiology[2], the answer to this question will involve a rule for identifying one's *effective axiology*: the axiology that one should use for guiding decisions, in whatever way one should generally use an axiology for guiding decisions (maximising, satisficing, maximising subject to certain side-constraints, or whatever). The question then becomes: how is one's effective axiology related to the various first-order axiologies in which one has non-zero credence?

The general literature on moral uncertainty suggests four approaches to answering this question. The first approach ignores the agent's credences (and beliefs), and says that effective axiology is simply the *true* axiology, no matter that the agent is in no position to know which this is (Harman (2011), Weatherson (2013); Mason (2015)). This is a singularly unhelpful answer to people who find themselves in this predicament, but its proponents argue that is the most one can say.

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[1] Similar questions occur in the context of group decision making in the presence of interpersonal disagreement. The approach we will explore in this paper could also be applied in that context. There are, however, more alternatives available for dealing with disagreement than for dealing with uncertainty (for example, voting), and space constraints prevent us from fully exploring the associated issues here.

[2] Matters are more complex in the more general case, in which one's normative uncertainty extends to both the axiological and the non-axiological parts of normative theory. It is a substantive question whether or not, in that general case, anything like an 'effective axiology' plays a role in appropriate choice under normative uncertainty. In this paper, we set these more complex issues aside, and focus on clarifying the simpler case.

A second approach says that the effective axiology is the one in which the agent has highest credence (the "My Favourite Theory" approach: Lockhart (2000), pp. 58-9; Gustafsson & Torpman (2014)). This approach sounds initially intuitive, but has several deeply unsatisfactory features: (1) It gives very counterintuitive results if there are many theories under consideration and your highest credence is low. For example, if you have a credence of 10% in your favourite axiology, then this approach to moral uncertainty may lead you to select an option that you are 90% sure is worse, when there was a rival option you were 90% sure was better. (2) It makes you indifferent to finding out what the other theories say (even if you have only slightly less credence in them), and thus cannot capture the intuition towards seeking out options that have broad support. (3) It is well-defined only relative to some privileged way of individuating theories, but it is not plausible that there is any such privileged individuation.

A third approach appeals to a notion of all-out belief, as opposed to credence: the effective axiology is the one that the agent *believes*. This theory inherits the third of the above problems with the "My Favourite Theory" approach; in addition, in any case involving significant axiological uncertainty, there is unlikely to be any axiology that that agent all-out *believes*, in which case this third approach is simply silent on what one is to do.

This brings us to the fourth approach: to use the same approach to axiological uncertainty that we use for empirical uncertainty, i.e. use an effective axiology that corresponds to the ordering of alternatives according to their *expected value*. This approach ranks options on the basis of the breadth of support across different theories (weighted by how likely those theories are), and also on the basis of how much each theory considers to be at stake. For instance, even if 60% of your credence is in theories that judge A to be slightly superior to B, if the remaining theories find A to be vastly worse, this could lower the expected moral value of A enough that the effective axiology ranks B above A.

In this paper, we will focus on this fourth alternative: the 'expected moral value' (EMV) approach to axiological uncertainty. In part this is because it is obvious what the other three approaches canvassed above recommend. But it is also because we find EMV to be a very plausible approach to axiological uncertainty (just as its analog is for empirical uncertainty) – both intrinsically, and because the problems for the alternative approaches strike us as serious.

What we will argue is that the EMV approach to axiological uncertainty implies, in a sense that we will make precise, that in certain 'large-population limits' the effective ranking of certain (potentially important) alternative-pairs under population-axiological uncertainty coincides with that of the Total View[3], even if one's credence in the Total View is arbitrarily low, and even if most of the alternative theories generate the opposite ranking of the alternatives under consideration. Readers who start out unsympathetic both to EMV as an approach to moral uncertainty and to the Total View as a first-order population axiology may be inclined to read this as a further *reductio* of EMV; we have some sympathy with this reaction, and we discuss the extent to which it is reasonable in section 9.

[3] Technically: with a Critical Level view, not the Total View itself. We defer discussion of this relative subtlety until section 6.

The remainder of the paper proceeds as follows.

While we seek to analyse the most general case of population-axiological uncertainty that we can, a fully general treatment lies beyond the scope of the present paper: for tractability, we will be restricting attention to axiologies that are in specifiable senses mathematically well-behaved. Section 2 flags the restrictions in question.

The biggest challenge for the EMV approach is in determining how the moral stakes on one theory line up with those on another. This is known as the *problem of intertheoretic comparisons* of value. Section 3 surveys the possible solutions to this problem; our own approach will be neutral between these solutions, requiring rejection only of the sceptical position according to which intertheoretic comparisons are impossible.

Section 4 highlights the fact, crucial to our later analysis, that according to the EMV approach to axiological uncertainty, the effective ranking of alternatives depends not only on the agent's credences in the various possible axiologies, but also on whether some axiologies judge there to be *more at stake* in the decision situation under consideration than other theories do. Existing work on moral uncertainty recognises the resulting possibility that in some cases, what one ought to do under uncertainty can reliably track what is recommended by some particular theory even when one's credence in that theory is relatively low; the key theme of our subsequent analysis is that something like this might systematically happen in population ethics. When it does, we say that the theory that 'carries the day' for practical purposes, despite the agent's low credence in that theory, *swamps* the rival theories.

Section 5 turns to the detailed investigation of the case of population axiology. We analyse three scenarios: (1) adding a single extra person; (2) taking some risky action that improves well-being for presently existing people but increases the risk of human extinction in the near future; (3) making some sacrifice in the well-being of present Earthbound humans in order to send expensive missions to seed new human civilisations on other planets. In all three types of case, we identify a precise sense in which, "in the limit of large populations", and for an agent whose credences are split between a specified (but quite wide) range of population axiologies but who has *nonzero* credence in the Total View, the alternative with the higher expected moral value is the one that is preferred by the Total View, despite the fact that it remains dispreferred by many rival theories.

Section 6 develops one minor refinement to the claims of section 5: The Total View is one member of a more general family of population axiologies, the 'Critical Level' family. When the class of population axiologies under consideration also includes other members of this family, in general the axiology that swamps others in large-population limits is not necessarily the Total View itself, but may be some other member of this family. This refinement, however, is unlikely significantly to alter the practical import of our conclusions. (This section is more technical than the remainder of the paper, and may be skipped by readers who are interested only on the broader features of our argument.)

Section 7 takes on the question of whether, granted that this 'swamping' occurs in a theoretical large-population limit, the 'swamping' will actually occur in practice: that is, are the population sizes

that are actually involved in empirically realistic versions of our scenarios sufficiently large? The issues here are somewhat complex, both because the relevant empirical parameters are themselves very uncertain, and because the manner in which one settles questions of intertheoretic comparisons will make a difference here. However, reasonable back-of-the-envelope calculations suggest that it is at least very plausible that the 'swamping' we discuss may actually occur.

Section 8 notes that for very similar reasons, the EMV approach to axiological uncertainty is committed to analogs of some versions of the notorious Repugnant Conclusion. Section 9 takes up the (related) question of whether one might take the 'swamping' results we have discussed as *reductios* of the EMV approach to moral uncertainty. Section 10 is the conclusion.

2. Restrictions to our analysis

In this paper, we will use some important simplifying assumptions. First, we will restrict our attention to population *axiology*: comparisons of states of affairs (possibly involving different populations) in terms of overall betterness. That is, we are focused on evaluative questions such as whether it would be better to have a larger population so long as the total well-being goes up, rather than directly on deontic questions of what one ought to do or to choose. (Similarly, the Total and Average Views that we discuss are not average and total *utilitarianism*, in the sense that they are only theories of the good: they say nothing about whether one *ought* to *maximise* goodness, or instead satisfice, maximise subject to side constraints, or anything else.) Importantly, this does not involve any assumption that axiology is the full moral story; most approaches to morality, consequentialist or otherwise, hold that considerations of overall betterness are at least *one important part* of the full story, and would thus agree that it is worth working out what that part looks like.[4]

Second, we will focus on axiologies that give cardinal values for these comparisons, such that we can ask how many times bigger the value difference between outcomes *A* and *B* is than the difference between outcomes *C* and *D*. This rules out merely ordinal axiologies, but in practice it includes all the main axiologies under discussion in population ethics.

Third, we will set aside theories where the betterness relation is incomplete or cyclic. While we have some sympathy with theories involving incomplete betterness, it introduces a number of choices for how to fit it into a theory of axiological uncertainty, and substantially complicates the analysis (see, e.g. MacAskill (2013)). Unlike the earlier ones, this assumption *is* a moderately large restriction in practice: the approaches of e.g. Bader (manuscript), Heyd (1988), and Temkin (1987, 2012) lie outside the scope of our discussion.

Finally, we set aside theories that violate axiological invariance: the requirement that the value of a state of affairs is independent of which state of affairs is actual. This principle is violated by 'actualist' theories (Bigelow and Pargetter (1988), Warren (1977), Arrhenius (Ch.10.3, forthcoming)).

[4] The point is made forcefully by Rawls, himself no consequentialist: "All ethical doctrines worth our attention take consequences into account in judging rightness. One which did not would simply be irrational, crazy." (Rawls (1971), p.30)

Including such theories in our analysis would be straightforward in principle and would not change our qualitative result, but it would complicate the analysis.

We are thus restricting our attention to theories of population ethics that are mathematically quite well behaved. This is a serious restriction to our analysis: clearly, any fully general treatment of axiological uncertainty will also have to say what one should do when one has non-zero credence (as one plausibly should) in some 'badly-behaved' theories, and will therefore have to address the deeper problems that are discussed by e.g. MacAskill (2013). The motivation for our restriction is pragmatic: we have very little idea of how to develop a plausible theory of axiological uncertainty for the fully general case, and in the meantime it seems worth working out what can be said about the more tractable cases.

3. The problem of intertheoretic comparisons

3.1 Skepticism about intertheoretic comparisons?

To construct an effective axiology on the EMV approach, we need to be able to compute, for any pair of alternatives A, B, whether the difference in expected moral value EMV(B) – EMV(A) is positive or negative: the EMV ordering ranks B above A iff this difference is positive. But that requires that we have a meaningful notion of averaging the value-differences between A and B according to rival axiologies; this in turn effectively requires that rival axiologies use the *same* scale of possible value-differences. How, though, is the value scale postulated by one axiology to be compared to that postulated by another?

Herein lie several challenges. The most sceptical position, vis-à-vis the possibility of such 'intertheoretic comparisons', is taken by John Broome (pp. 185, 2012), who argues that intertheoretic comparisons between (by way of example) the Average View and the Total View are impossible on the grounds that those two theories simply employ different *units* of value: respectively, average well-being and total well-being. Broome complains that since there is no well-defined operation of addition (and hence averaging) between m units of average well-being and n units of total well-being, it is impossible to evaluate 'expected moral value' when one's credence is split between these two theories.

In fact, it is not true that the Average View and the Total View employ different units: they both employ units of well-being (since average well-being is just total well-being divided by a *dimensionless* number). But even given two theories that at first glance genuinely do employ different units – even if, say, one theory measured value in terms of number of apples while the other measured value in terms of number of oranges – this would be no obstacle to our building an overall theory that included mappings from the apples-scale and the oranges-scale to some common value-space.[5] Nor is it obscure what such an exercise would amount to: it would amount to deciding

[5]Technically, since on the EMV approach we are only concerned with comparing value *differences,* and not value *levels,* across theories: mappings from apples-differences and oranges-differences to some common space of value-differences. We will henceforth ignore this complication, for simplicity of exposition.

how important it is to increase number of apples conditional on the supposition that the apples-theory is true, compared to how important it is to increase number of oranges conditional on the supposition that the oranges-theory is true.

A lesser (but still fatal) degree of scepticism holds that while there is indeed no such obstacle in principle to the moral-value ascriptions made by two rival theories lying on a common scale, total incomparability nonetheless remains because there is simply no fact of the matter as to which of the infinitely many particular ways of rendering them commensurate is the 'correct' one. This perspective is highly natural if one's starting point is what the theories under consideration, at least as considered *outside* the context of axiological uncertainty, individually say. Suppose, for example, that A, B are alternative possible populations as follows:

	Average well-being	Population size	Total well-being
A	50	4	200
B	25	16	400

In this example, one might naively think, for an agent who has credence ½ in each of the Total and Average Views, that the difference in expected moral value between alternatives A and B is given by

$$EMV(B) - EMV(A) = \tfrac{1}{2} \times (25 - 50) + \tfrac{1}{2} \times (400 - 200) > 0,$$

in which case the effective axiology ranks B above A. However, if the only facts there are are restricted to what the rival views each *separately* say about (i) the ordering of alternatives and (ii) the ratios of such value-differences between alternatives, then we have freedom to rescale each axiology's value function by a *separate* positive linear transformation. We might just as well, for instance, have represented the Average View by means of a value function according to which V(A)= 50 million and V(B) = 25 million (while still using the values 200, 400 for the Total View's values); but doing so would, of course, have reversed the result of the above calculation.

The basic problem here arises because neither the Average View nor the Total View says whether the magnitude of the value difference between A and B *according to the Average View* is greater than the magnitude of the value difference between the same two alternatives *according to the Total View*. That is, (one might think that) while intertheoretic comparisons are (*pace* Broome) not ruled out by the very nature of the respective units of value, still there are none. If this sceptical position on intertheoretic comparisons is correct, then once again, the EMV approach to axiological uncertainty is doomed. The subsequent analysis in our paper will require that we have rejected both the sceptical positions just discussed.

3.2 Three non-skeptical approaches

There are three more positive approaches to the issue of intertheoretic comparisons.

The first approach is *content-based*. This approach is available if (as is sometimes, but not always, the case) there is some significant subset of alternatives such that the two theories in question agree

on all ratios of value differences regarding pairs of alternatives in the privileged subset. In that case, it is *natural* (although of course not analytically required) to require unit intertheoretic comparisons on the region of overlap; this requirement, together with the existing intratheoretic structure within each theory, then determines the intertheoretic comparisons elsewhere. As an example, consider someone whose credence is split between the Total View on the one hand, and a presentist person-affecting view on the other. The latter view is one way of trying to flesh out the intuition that "We are in favor of making people happy, but neutral about making happy people" (p. 80, Narveson (1973)): on this view, only people who presently exist at the time of the decision count from a moral point of view. There appears to be a natural way of comparing values between these theories, as it seems they agree about the nature of value, but disagree about the bearers of value. One could set the value of a unit of well-being in a person's life according to the Total View to be equal to the value of a unit of well-being in a presently existing person's life according to the presentist theory. The two theories would then agree on the intrinsic value of (say) improving the health or lengthening the life of an already existing person, but the Total View would hold that it is ten times as valuable to improve the lives of ten future people by a given amount than it is to improve the life of one present person by that same amount, while the presentist theory would hold that improving the lives of future persons generates no gain in value at all.

The second approach is the *structure-based* approach to intertheoretic comparisons. This approach seeks a way of normalising theories against one another that is 'purely structural' in the sense that, unlike the first approach just mentioned, it does not attribute any significance to the *content* of an alternative, but utilises only the ratios of value differences postulated by the theories to be ranked. The most commonly discussed normalisation rule in this family is the 'zero-one' or 'range normalisation' method, according to which the value difference between the best and worst alternative is the same for each theory; Owen Cotton-Barratt, William MacAskill and Toby Ord (preprint) have recently argued for the superiority of an alternative 'variance normalisation' approach over others in the structuralist family, in part (but not only) because range normalisation is defined only for bounded value functions. One key decision point for such a 'structural' approach is whether, for the purpose of a particular choice situation, to normalise the range of values of the options in that choice situation, or to normalise it across a broader set of options, such as all possible options. The former has the formal problem of choice-set dependence, while the latter is difficult to precisely define. Herein lie the disadvantages of the structural approach; its advantage over the content-based approach, meanwhile, is that it remains available even when comparing theories that are so radically different that the common ground required by the content-based approach does not exist.

The third approach is *subjectivist*. This is an analogue of subjectivism about credences: subjective Bayesians hold that each agent is rationally required to have settled (somehow) on some credence function, but that there is a wide range of rationally permissible credence functions, and no rules or guidelines to guide the choice amongst them. In the context of intertheoretic comparisons, the analogous view holds that each agent is rationally required to have settled (somehow) on some standard of intertheoretic comparisons, but there is a wide range of rationally permissible such standards (including, but certainly not restricted to, the ones that correspond to some reasonably

natural content-based or structuralist approach), and no rules or guidelines to guide the choice amongst them.

Our subsequent discussion will assume that some such positive view is correct, but (with the exception of section 7) will be neutral as to which.

4. The importance of relative stakes

A key tenet of the EMV approach is the idea that in a particular decision situation, if one moral theory holds that there is a lot at stake while rival theories regard relatively little as being at stake, then one should sway one's ranking of alternatives towards that recommended by the 'high-stakes' theory, relative to what one might expect based on one's credences alone. For instance, if one has equal credence in two theories and those two theories disagree as to which of two given alternatives is better, then one should choose according to the theory that regards this particular choice as being higher-stakes. For another type of example, sometimes one should follow the dictates of a theory in which one has relatively *low* credence, even when that theory disagrees with all other theories in which one has nonzero credence on the relative ranking of two particular alternatives — if the low-credence theory alone regards the choice between this particular pair of alternatives as being high-stakes.

This is, of course, all analogous to the verdicts of *ordinary* expected utility theory on cases of *empirical* uncertainty. One should not accept a gamble according to which one gains £10 if the fair coin lands heads, but loses £1000 if it lands tails, despite the fact that one has equal credences that one would win or lose such a bet. And under at least some circumstances, one should take precautions even against events that one considers to be relatively unlikely: one's credence that one's bike would be stolen on any given day if one neglected to lock it up outside one's office, for instance, is probably less than 5%, but still one locks it, since it costs much less to turn the key than it would to lose the bike

This possibility of one theory's "swamping" another within the EMV approach, on grounds of differential stakes and beyond the point that one would expect on grounds of credence alone, has received some limited discussion in the moral-uncertainty literature. Most obviously, as Ross (2006) and MacAskill (2013) have both noted, a 'uniform' theory according to which every alternative is equally as good as every other alternative has the property that the ranking of alternatives by expected moral value depends only on one's relative credences in non-uniform theories: one's credence, if any, in the uniform theory has no effect. Even if one has credence 0.999, say, in a uniform theory, with the remaining 0.001 credence distributed equally between two non-uniform theories T1 and T2, one's EMV ranking of alternatives will be identical to the ranking that one would have if one had credence ½ in each of T1 and T2, and zero credence in the uniform theory. In this sense, except in the extreme case of credence 1 in the uniform theory, non-uniform theories "swamp" uniform theories.

This phenomenon of *total silencing* of one theory by others on grounds of relative stakes is an extreme case. More commonly, but more messily, similar things can occur when one theory judges that the amount at stake is *much less* than other theories think. For the simplest instance of this,

suppose that one starts with two rival theories ('Theory 1' and 'Theory 2') and a relatively natural construal of the intertheoretic comparisons between them, but then decides that the version of Theory 2 in which one actually has nonzero credence is a 'hysterical' theory one that deems *everything* one million times more important than the 'natural' version did. (This particular description, of course, makes sense only on the 'subjectivist' approach to intertheoretic comparisons, since any strict content- or structure-based approach would leave no freedom for such 'rescaling'.) In that case, *for fixed relative credences in Theories 1 and 2*, Theory 2 will now contribute one million times more to the relevant expected value calculations than it did previously, and may thereby 'swamp' Theory 1. In this simple instance, however, the 'swamping' is easily avoided simply by having very low (but not necessarily zero) credence in such 'hysterical' theories, a move that independently seems quite reasonable.

The project of this paper is to explore a more subtle instantiation of the phenomenon of swamping via extreme relative stakes, in the specific context of population ethics. Section 5 begins this task, by analysing three scenarios of distinct structures, and considering the results of applying EMV when credences are split between a fairly wide family of population axiologies (subject to the limitations noted in section 2, above).

5. Scenarios

5.1 Preliminaries

In order better to understand how the changes in relative stakes can affect decisions under uncertainty, we will explore three hypothetical scenarios, concerning (1) mere additions, (2) extinction risk and (3) space colonisation. A general theme we will follow is that as the scenarios involve more and more people (in a sense that can be made precise on a case-by-case basis), the Total View ascribes the choice a higher relative weight, eventually coming to dominate the ranking of actions according to the EMV view of axiological uncertainty, regardless of one's credence in the Total View (provided only that it is nonzero) and regardless of how the intertheoretic comparisons have been fixed.

We will use the following notation. For an arbitrary population X, let $|X|$ be the number of people in X, and let $\overline{X}$ be the average well-being level in X. In this notation, the total well-being in X is $\overline{X}|X|$. For an arbitrary population X and natural number n, write nX for the population that consists of 'n copies of X' (that is, for every well-being level w, if X contains exactly m people at well-being level w, then nX contains exactly nm people at well-being level w).

5.2 Axiologies under consideration

Using the notation above, we can easily compare a number of extant population axiologies.[6] As we shall see, most of these involve calculating the product of some form of an average well-being with some form of the number of people, producing something akin to a total well-being.

[6] Our list includes every actually-advocated theory we are aware of that is both (i) sufficiently precisely specified for us to know what the corresponding value function is, and (ii) consistent with the structural

In our notation, the Total View and Average View are represented by the following value functions:

Total: $V(X) = \overline{X}\,|X|$

Average: $V(X) = \overline{X}$

We also consider two types of Variable Value view, in which there is a kind of diminishing marginal value in creating extra people (hence the value of adding a particular life can vary). These are from Hurka (p. 502-4, 1983), and correspond respectively to his theories "V1" and "V2":[7]

Variable Value I: $V(X) = \overline{X}\,g(|X|)$ where g is a strictly increasing and strictly concave function with a horizontal asymptote, g^*

Variable Value II: $V(X) = f(\overline{X})g(|X|)$ where f and g are strictly increasing and strictly concave functions and g has a horizontal asymptote, g^*

We then consider two 'person affecting' views, which attempt to cash out the intuition that 'we are in favor of making people happy, but neutral about making happy people' Narveson (1973). Presentism (Arrhenius 'population ethics…', ch. 10.1) is the view that only past and present people matter morally: people who will come into existence in the future are considered to have no moral value at the time a decision is made. Necessitarianism (pp. 103-4, Singer (1979), Ch. 10.2, Arrhenius (forthcoming)) is the view that only people who will exist regardless of the choice you are currently making matter from a moral point of view. Assuming that these theories further take the value of the state of affairs to be the *sum* of the well-being of all people who have moral value,[8] these theories are represented respectively by the following value functions:

Presentism: $V(X) = \overline{P}|P|$ where P is all people in X who presently exist

Necessitarianism: $V(X) = \overline{N}|N|$ where N is all people in X who exist in all alternatives

Finally, we will eventually also consider the Critical Level family of views that has been defended by Broome (2004) and by Blackorby, Bossert, and Donaldson (1995):

Critical Level: $V(X) = (\overline{X} - \alpha)|X|$ where α is a specific well-being level

This theory says that the value of adding an extra person to the world, if it is done in such a way as to leave the well-being levels of others unaffected, is equal to the new person's well-being level *minus* the constant α. Thus, according to this theory, adding an extra person with a well-being level

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limitations that we laid out in section 2. While we don't explicitly discuss it here, our results also hold for Geometrism (Sider (1991)) — a theory that was described but never seriously advocated.

[7] Note that Variable Value I is identical to the view Ng (1989) calls "Theory X'".

[8] Including other versions of the Presentist and/or Necessitarian views would further complicate our analysis, but we are not aware of any extant (or at all plausible) precisification that would alter our qualitative conclusions.

of precisely α is neutral in terms of overall value; adding a person with well-being level $w > \alpha$ is an improvement; adding a person with well-being level $w < \alpha$ makes things worse, even if the new person has a life worth living (i.e. even if $w > 0$). (The combination '$w > 0$ and $w < \alpha$' is of course possible only if $\alpha > 0$, but advocates of the Critical Level theory generally do propose $\alpha > 0$.)

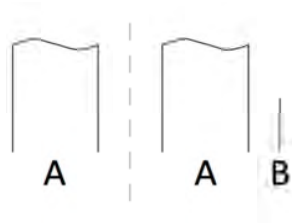
We have listed the Critical Level theory here for completeness, but for ease of exposition, we shall set it aside until section 6; in the present section, we consider the case in which credences are split between the other theories on the above list.

Note that none of these axiologies are sensitive to how well-being is distributed within a population. However, it is quite easy to tweak them to construct distribution-sensitive versions. For example, if one uses a different form of average (a generalised mean instead of the arithmetic mean), one can end up with prioritarianism.[9] This lets one have total, average, variable-value, and person-affecting versions of prioritarianism. Nothing we say below depends on the type of mean used, so our results apply to all of these theories too.

Note also that the above statements of the respective value functions do not imply that the units of value are directly comparable between the theories. We could apply additional scalling factors to compare them.

5.3 Scenario 1: Adding a single person

For our first scenario, suppose that the two populations we seek to compare differ only via the addition of a single person, whose well-being level is above zero but is below the average:



In this and other similar diagrams, we use a wavy top for the box representing a population to mean that the population need not all have the same well-being level — the height is just an average level.

Different axiologies give different verdicts about whether the larger population is better, and by how much. The amount by which the larger population is better can be expressed as the value of the larger population minus the value of the smaller, or $V(A \cup B) - V(A)$. The axiologies disagree about whether this expression is positive or negative, and about its magnitude.

[9] For example, using a geometric mean corresponds to a logarithmic priority function and a root square mean corresponds to the square root priority function. In both cases, these incorporate a Fleurbaey transformation, which takes a particular approach to how prioritarianism should interact with uncertain outcomes. Other approaches to uncertainty can be accommodated, but we won't end up with generalized means in those cases.

In this section, we are particularly interested in what happens for large populations. We formalise this by considering what happens as the size of the population approaches infinity ($|A| \to \infty$) while both the average well-being in A and the well-being of the added 'B-person' are kept fixed.[10] Loosely speaking, what happens in this case is that the theories that posit a negative value to adding another person (with below-average well-being) care less and less about this when the base population gets higher (tending towards indifference), while the theory that posits a positive value to adding another person (as long as that person's well-being level is positive) care just as much about this in all cases.

In more detail: here is what our various candidate axiologies have to say about the large-population limit $|A| \to \infty$:

	Value difference as $|A| \to \infty$	*Explanation*
Total:	$V(A \cup B) - V(A) = \overline{B}$	i.e. A∪B is better by $\overline{B}$ units
Average:	$V(A \cup B) - V(A) \to 0$	as the averages converge
Variable Value I:	$V(A \cup B) - V(A) \to 0$	as the averages converge and the difference between $g(\|A\|)$ and $g(\|A \cup B\|)$ vanishes
Variable Value II:	$V(A \cup B) - V(A) \to 0$	as the averages converge and the difference between $g(\|A\|)$ and $g(\|A \cup B\|)$ vanishes
Presentism:	$V(A \cup B) - V(A) = 0$	as the person in B cannot be present at the time of choice so those present have unchanged well-being
Necessitarianism:	$V(A \cup B) - V(A) = 0$	as the necessary people have the same distribution of well-being in both cases

Thus on these views, as the number of people who are guaranteed to exist increases, the value of adding another person is either a fixed positive amount ($\overline{B}$), or tends to zero. The lack of any axiology positing a fixed negative value[11] to adding this additional person has a striking effect on the effective axiology according to the EMV approach: for any fixed set of non-zero credences in these axiologies and any fixed way of drawing intertheoretic comparisons, for a sufficiently large base population the EMV approach ranks adding an extra person with a life worth living above not adding them, even when that lowers the overall average. This is true regardless of how intertheoretic comparisons are performed, because the ratio of the amount at stake according to the Total View to the amount at

[10] If we used a distribution sensitive theory, we would also have to make sure the shape of the distribution of well-being in D were kept roughly the same while the size of the population is scaled up.

[11] *Critical Level* views might postulate a fixed negative value for the addition of an extra person with positive well-being – that will happen whenever the extra person's well-being, although positive, is below the 'critical level'. As advertised above, we defer detailed exploration of Critical Level views to section 6.

stake according to other views approaches infinity, overwhelming any constant factor that arises when comparing value differences between two different theories.

Interestingly, this goes against a common intuition (Hurka (1983)) that such 'below-par additions' tend to amount to an overall improvement if the pre-existing population is *small*, but to make it worse if the pre-existing population is *large*. Indeed, it is largely on the grounds of that intuition that 'variable value theories' (Hurka (1983), Ng (1989)) seek to mimic the Total View at small populations, but the Average View at large populations. In contrast, we have shown that under the EMV approach to axiological uncertainty, the result of splitting one's credence either between the Total View and the Average View, or between all of the theories listed above, is *precisely the opposite*: in the above-specified sense, one's effective axiology defers to the Total View when the pre-existing population is sufficiently *large*, and is more likely to agree with the Average View when the pre-existing population is *small*.

5.4 Scenario 2: Extinction risk

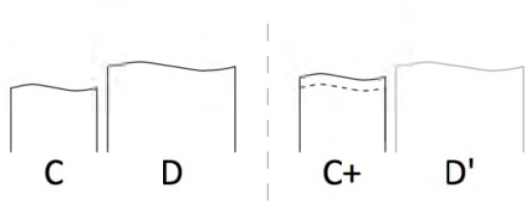
Suppose we have the option of performing some action that would certainly slightly raise the well-being of the present generation, but that would also generate a non-zero chance of extinction.[12] For the sake of simplicity, let us model extinction as the non-existence of any generation after the present one. There are then three possibilities:

1) We do nothing ('Safe'), in which case past and present people have their 'status quo' well-being levels, and there are also future people.

2) We perform the action ('Risky'), and get away with it: past people are unaffected, present people have a slightly increased well-being level relative to the 'status quo', and future people are just as in case (1).

3) We perform the action ('Risky'), but extinction results: past people are unaffected, present people enjoy the increased well-being level as in case (2), but there are no future people.

We can represent this scenario as follows:



Here C and C+ are the same population (representing the past and present people), but with a higher average well-being in C+. The potential future people are represented by D and D'. D' either

[12] More realistically: that would slightly raise the chance of extinction. We set aside other sources of extinction risk for simplicity of exposition; including it would complicate the detailed expression of our analysis, but would not affect its basic points.

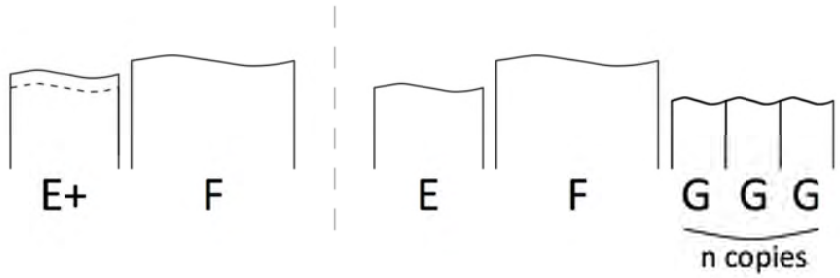
represents the same population as D or (with a small probability, p) represents an empty population. We shall set this up with well-being averages as follows: $\overline{C} < \overline{C+} < \overline{D} = \overline{D'}$.

In this scenario, the 'large-population limit' we will consider is that in which the size of the possible future population tends to infinity: $|D| \to \infty$. In that limit, the Total View again swamps the rival views we are considering, although in this case this happens for a structurally different reason than in the case of the Mere Addition scenario discussed above. In the Extinction Risk case, as $|D| \to \infty$, we have $V_{Total}(Safe) - V_{Total}(Risky) \to \infty$, while the value difference according to any axiology that ranks Risky over Safe at most approaches a finite bound. Therefore the *ratio* of this value-difference according to the Total View to the corresponding value-difference according to any of the rival views currently under consideration again approaches infinity, so that the Total View again swamps these rival theories in the large-population limit.

5.5 Scenario 3: Space colonisation

In the future, we may reach a time where we have the option of colonising other planets — potentially, a very large number of other planets. This would involve some well-being cost to the people present at that time, but would dramatically increase the number of people who live in the future. Living space on Earth is limited, but settling other planets would permit a much larger Total population at any given future time — not to mention the fact that our own Sun will eventually die. It is extremely unclear how the average well-being level of those who would thereby live on other planets would compare to that of future Earth-dwellers: that would depend on what conditions on the other planets in question turn out to be. Thus, colonisation may or may not turn out to be a good move according to the Average View. Given the assumed cost to present people, however, it *is* clear that investing in colonisation would be a bad move according to a presentist or necessitarian person-affecting theory. Meanwhile, it is likely to be a good move, and potentially a *very* good move, according to the Total View: for even modest human population sizes on other planets, the increase in total well-being due to the increase in population size is likely to trump the costs of colonisation (Bostrom (2003)).

A natural model of this scenario is as follows. Let E+ denote the population consisting of all past and present lives at the time humanity is deciding whether to colonise other planets. If colonisation goes ahead, this population is replaced with E, which consists of the same people as E+ but with slightly lower average well-being. Let F be the population consisting of all lives *on Earth* after the time of possible colonisation. We assume, harmlessly idealising for the sake of simplicity, that F is unaffected by whether or not the colonisation project goes ahead (perhaps because the costs of the colonisation project have been borne entirely by the E-people, and there is no further interaction between Earth and the colonies once the latter are established). Let G be a typical colony-population. For the sake of the further analysis, it does not matter how high the well-being in G is, so long as it is positive, but since the theories disagree the most when it is low, we shall illustrate it thus. We might establish several colonies, in which case the aggregate off-Earth population is some constant scaling-up nG of G: the sense of "large population limit" that we will consider in conjunction with this scenario is that of "large number of settled planets". Our choice is then between the populations $E+ \cup F$ (no colonisation) on the one hand, and $E \cup F \cup nG$ (colonisation) on the other:



The 'large-population limit' we will consider in this case is the limit $n \to \infty$: that is, the limit in which the number of possible colony inhabitants tends to infinity. For sufficiently large such populations, much as for the Extinction Risk scenario, the Total View favours colonisation over non-colonisation, *and does so by an amount that increases without bound as n increases*. In contrast, while various other views favour non-colonisation over colonisation, they do so by at most an amount that remains bounded as n goes to infinity. Therefore, in the limit $n \to \infty$, the Total View swamps the rival theories that we are considering.

5.6 Further properties

We have seen that in all three scenarios, if we spread out credence between the axiologies we have considered, the highest-ranked alternative under the EMV approach to axiological uncertainty is the same as the alternative that is highest-ranked by the Total View, when the number of people involved gets large enough. This eventually happens for any non-zero credence in the Total View, no matter how low.

As well as this, there are two related results. First, the way that the Total View came to swamp its rivals was by having the amount at stake become many times as much as that posited by the other axiologies, without limit.. This means that not only does the alternative recommended by Total eventually get an expected moral value that is higher than the other alternative, the difference between these expected moral values of the alternatives grows without bound, and the ratio between them grows without bound. This matters when it comes to empirical uncertainty, because it can mean that even when there is only a *low chance* of the alternatives leading to situations like those in the scenarios (e.g. a choice where one alternative only slightly increases the chance of space colonisation), according to the EMV approach the effective axiology would still agree with the Total View, when the size of the possible population at stake is sufficiently high.

Second, the difference in expected moral value between the alternatives changes *monotonically* as the number of people affected is scaled up. That is, *all* increases in the population improve the relative standing of the alternative that the Total View favours. This implies that once the alternative that is top-ranked by the Total View becomes top-ranked in the effective axiology, it remains top-ranked as the population is scaled up — there is no oscillation back and forth.

In addition to the restrictions that we advertised in section 2, our results are, however, limited in the following two senses.

First: we have shown only that *of the axiologies we have considered*, all but critical level theories are swamped by the Total View in the specified large-population limits. We have of course not claimed that there is *no possible* population axiology that would not be swamped in this way. That further claim is clearly false: one mathematically possible (but substantively completely implausible) such axiology, for example, is the one we might call 'the Reverse Total View', according to which the value of any state of affairs is precisely *minus* the value that (ordinarily) the Total View assigns to it.

The more interesting possibility is that there might be some *reasonably plausible* population axiology that we have not considered, and that would (nevertheless) not be swamped in the cases we have discussed. We have no non-existence proof here. But it is worth noting what it takes for a theory to avoid swamping in these cases: the theory must hold, in our scenarios of Extinction Risk and Space Colonisation, not only that the alternative favoured by The Total View is inferior in the large-population limit, but that the *amount* by which it is inferior grows without bound as the relevant population size increases. In the Extinction Risk case such a theory must, for example, have a preference for Risky over Safe that gets stronger and stronger, without bound, as the size of the threatened possible future population increases. This condition seems difficult to meet; while there may be serious candidate axiologies that we have not considered, we doubt that any of them will meet the conditions needed to avoid swamping. We are aware of only one partial exception, to which we turn in section 6.

Second: so far, we have shown only that *in the limit as the relevant population size goes to infinity*, the Total View swamps the extant rival theories. For practical purposes, these limit results supply a useful heuristic: it is *worth considering the question* of whether actual population sizes are sufficiently large. But nothing that we have said so far takes on the question of whether swamping will actually occur in practice, rather than only in theory. We address this in section 7.

6. Critical Level axiologies

As explained in Section 5, the Total View is a member of the 'Critical Level' family of axiologies, corresponding to the special case in which the critical level is zero. The caveat to the 'swamping' claims we made in section 5 is this: strictly speaking, the theory that 'swamps' others in our large-population limits will usually not be the Total View itself, but some other member of this Critical Level family. Like the Total View, all Critical Level theories have non-diminishing returns to the value of additional people, and thus tend to generate unbounded values in large-population limits.

But what happens in cases where you have non-zero credence in two different Critical Level axiologies, where the value of the critical level is different? While we omit the details due to lack of space, it can be easily proven that the contributions to the expected moral value made by your credence in multiple Critical Level theories is just the same as if all that credence was placed in a single Critical Level theory — whose critical level is set to be a weighted average of the individual ones. For example, if you have 40% credence in the Total View and 10% credence in a Critical Level theory whose level is α, then the expected moral value of any option will be exactly the same as if you instead had credence 50% in a Critical Level theory, whose level was $\alpha/5$.

Arguably, however, this modification is unlikely to make very much difference to our qualitative conclusions. For example, in the Extinction Risk and Space Colonisation scenarios it is reasonable to suppose that the additional people have wellbeing greater than the weighted average of plausible critical levels. If so, the combined Critical Level views also push in favour of avoiding extinction risk and settling the cosmos. However, if a scenario envisaged rather mediocre additional lives or if one had a lot of credence in Critical Level theories with a very high bar, then the conclusions could be reversed, with the Critical Level theory's aversion to a large population swamping any other theories that were in favour of risk reduction or expansion.

7. Empirical analysis of existential risk and space colonisation

7.1 Preliminaries

What we have argued so far is that for the three scenarios outlined*, in the limit of large affected populations*, EMV recommends the same alternative as one's effective Critical Level theory, even if one thinks it is overwhelmingly likely that that alternative is the inferior option. But how large does a population have to be in practice before this happens? In particular, will this 'swamping' of other theories by the Total and Critical Level theories ever actually happen in practice, or is it merely a theoretical curiosity?

This question can be answered only by crunching the numbers for plausible estimates of (for instance) the expected remaining lifespan of humanity (for the Extinction Risk scenario) or the number of future persons who might exist if we succeeded in colonising space (for the Space Colonisation scenario), and the rough size of cost in terms of present well-being that might be associated with lowering extinction risk or colonising space (respectively), and the amount by which this sacrifice of present well-being might succeed in reducing extinction risk (in that scenario). Any such estimate is open to significant debate. However, for illustrative purposes, here we will sketch how the numbers fall for estimates that we ourselves consider quite reasonable.

To simplify the calculations, we will consider the case of an agent who has nonzero credence only in The Total View and a Person-Affecting theory. The inclusion of other axiologies would be unlikely significantly to alter our qualitative conclusions, but would vastly complicate the analysis.

The calculations in question are, of course, crucially affected by how one draws intertheoretic comparisons between a Totalist and a Person-Affecting value scale. In section 3, we outlined two relatively specific ways of fixing intertheoretic comparisons, drawing respectively on 'content' and on 'structure'. Our conclusions will be that on the content-based approach the kind of swamping we have been discussing is indeed moderately likely to occur in practice, and not only in theory; on a structuralist approach matters are more complex, and all bets are off.

7.2 Content-based intertheoretic comparisons

We will first assume that the value scales of the Totalist theory and Person-Affecting theories are normalised against one another according to the natural 'content-based' prescription mentioned in section 3: that is, we will assume that these theories agree with one another about the value of any

given change to the well-being of an already existing person, and merely disagree about whether or not future/non-necessary persons have any axiological significance at all.

In the Extinction Risk scenario: Suppose, for instance, that the expected remaining lifespan of humanity is 1,000,000 years[13], and that there will on average be an additional 7 billion people per century until humanity goes extinct. Suppose that the amount of well-being that the present generation would forgo in order to reduce extinction risk amounts to 1% of each person's lifetime well-being level, and suppose that this sacrifice would reduce the probability of imminent extinction by 1 in a million. Then the amount by which The Total View favours the Safe option over the Risky one is 99 times the amount by which a Person-Affecting theory favours Risky over Safe. Therefore, provided our agent's credence in The Total View is more than about 1 percent of one's credence in Person-Affecting theories, under axiological uncertainty (according to EMV, and with the intertheoretic comparisons fixed as stated above) The Total View swamps the Person-Affecting theory for the purposes of this particular decision.

The analysis for space colonization has much in common with that of existential risk. If we could settle many new worlds with populations that last many generations and have a good quality of life, it is easy to see how the Total View could assign this a very high value relative to the value of improving the well-being of a single generation. In fact, it seems substantially easier for The Total View to swamp person-affecting views in the Colonisation case than in the Extinction Risk case.

Numbers for the Colonisation case are even more speculative than for Extinction Risk, but the qualitative conclusions are robust to changing the numbers by a large amount. Let us ask what would happen if we could settle one in a thousand of the planets in our galaxy (and no planets elsewhere). This would be about 100,000 new planets. We shall suppose, fairly conservatively, that each settlement would last an average of 200,000 years, that they will have a tenth as many people as the earth did at the time the colonisation begins, and that their quality of life will only be half as good. Let's suppose that in order to launch the colonisation, present people must sacrifice enough to reduce their quality of life by 10% for 100 years (which we are supposing would be enough to start a cascade of colonies, each of which can colonise further, eventually reaching all 100,000 new planets). In this case, the amount by which the Total View favours colonising is *100 million* times the amount by which a Person-Affecting theory favours not colonising, so that our agent would favour colonisation provided only that her credence in The Total View was more than about 1 in 100 million. This is an enormous ratio; for any remotely reasonable relative credences, the Total View would still swamp a Person-Affecting theory even if the numbers were changed to be much less favourable (e.g. if the colonies only lasted 1,000 years and there were only 10 of them).

7.3 Structuralist intertheoretic comparisons

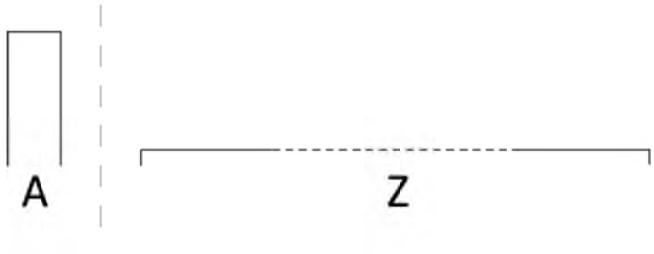
[13] For context: the species *Homo Sapiens* has already been around for 200,000 years; the average mammalian species lasts for 1-2 million years; the average historical frequency of mass extinction events is 1 per 100 million years; the heating-up of the Sun will dry out the Earth in something over 1 billion years' time. Note that we are interested in humanity's *expected* remaining lifespan, so that even a small credence in lifespans anywhere near the upper end of this range can substantially increase the figure that is relevant for our purposes. While there is room for plenty of debate here, in our view this makes our suggested figure of 1,000,000 if anything a very conservative estimate.

The back-of-the-envelope calculations of section 7.2 made essential use of the content-based method of fixing intertheoretic comparisons; what, then, of structuralist approaches? One of the key *motivations* of structuralist approaches is to ensure that rival moral theories have (in some sense) 'equal say' in decisions when the agent's credence is split equally between the theories in question. This makes swamping considerably more difficult. It turns out, however, that swamping can occur, but only on some structuralist approaches[14] and in a more complex set of circumstances.

8. The Effective Repugnant Conclusion

The Total View notoriously implies

> *The Repugnant Conclusion (RC): For any state of affairs A, no matter how large the population is and no matter how high people's well-being levels are in A, there is a better state of affairs, Z, in which no-one has a life that is more than barely worth living.*



Virtually everyone has at least some degree of pretheoretic intuition that the Repugnant Conclusion is false. Defenders of the Total View argue that this intuition is not in the end to be trusted. For most people, however avoidance of the Repugnant Conclusion is a very strong desideratum.

Consider now

> *The Effective Repugnant Conclusion (ERC): For any state of affairs A, no matter how large the population is and no matter how high people's well-being levels are in A, there is a state of affairs, Z, in which no-one has a life that is more than barely worth living, such that the effective axiology ranks Z above A.*

At first sight, one might suspect that the EMV approach to axiological uncertainty implies the Effective Repugnant Conclusion, for reasons similar to those given in section 5 for our four scenario-types of primary interest. And, if so, those who think the first-order Repugnant Conclusion is strong evidence against the Total View might well think that the Effective Repugnant Conclusion is strong evidence against the EMV approach.

In reply to this, three comments are in order. First comment: in fact the EMV approach does not imply ERC, for the reasons given in section 6: the theory that 'swamps' others in large-population limits is not necessarily The Total View, but rather one's effective Critical Level theory. But, as in

[14] Such as whether you normalise by range or by variance, and whether you normalise over all options in the choice at hand or over a wider set.

first-order discussions of Critical Level theories, it is debatable whether this sweetens the pill enough: the EMV approach to axiological uncertainty *does* imply

> *The Effective Weak Repugnant Conclusion (EWRC): For any state of affairs A, no matter how large the population is and no matter how high people's well-being levels are in A, there is a state of affairs, Z', in which no-one has a life that is more than barely above the effective critical level, and such that the effective axiology ranks Z above A.*

How bad this is depends, of course, on how high one's effective critical level is. But an effective critical level that is too high will give rise to further problems, and in any case at least *some* agents will have an effective critical level that is very close to zero (perhaps because their credence in The Total View, conditional on the proposition that some Critical Level theory is true, is high). For those agents, the Effective Weak Repugnant Conclusion is scarcely different in substance from the Effective Repugnant Conclusion. The fact that strictly speaking the EMV approach implies 'only' the Effective Weak Repugnant Conclusion, and not the Effective Repugnant Conclusion itself, is therefore unlikely to satisfy those who find the Effective Repugnant Conclusion implausible in the first place.

Second comment: even the (non-Weak) Effective Repugnant Conclusion is at least *somewhat* more plausible than the first-order Repugnant Conclusion. Granted, the majority of non-Total axiologies rank the A-world above the Z-world, but they generally think that the difference in value between any given A-world and any Z-world is *relatively* modest. In contrast, The Total View holds that sufficiently large Z-worlds are *much, much* better than any given A-world, by an amount that grows without bound as the size of Z increases. The sort of considerations of relative stakes that we have been considering in this paper, therefore – precisely the considerations that cause EMV to imply some form of Effective Repugnant Conclusion – also serve as an explanation of why an Effective Repugnant Conclusion might be true, even if the first-order Repugnant Conclusion is false. We assume, however, that many of those who find the Repugnant Conclusion implausible in the first place will also have recalcitrant intuitions against the Effective Repugnant Conclusion, this consideration notwithstanding.

Third comment: section 7 raised the possibility that if intertheoretic comparisons are fixed in a structuralist (variance-normalisation) way, then while swamping is a real theoretical phenomenon in cases of sufficiently large populations, it is an entirely open question whether or not realistic empirical parameters are such that swamping will actually occur in realistic Extinction Risk and/or Space Colonisation cases. There is, however, no hope of avoiding the fact that the EMV approach to axiological uncertainty implies the Effective Weak Repugnant Conclusion via any analogous considerations, since Repugnant Conclusions are and always have been matters of purely *theoretical* large-population limits.

9. Reductio?

We have argued that according to the EMV approach to axiological uncertainty, (i) for three fairly realistic decision scenarios, the Total and Critical Level views 'swamp' other extant axiologies in specified large-population limits, (ii) depending on the details of how intertheoretic comparisons are

settled, it is at least somewhat plausible that such 'swamping' will actually occur with empirically realistic parameter values, and (iii) the Effective Weak Repugnant Conclusion is true.

As with any argument, our arguments themselves are silent on the question of whether the appropriate reaction is to accept their conclusions, or reject one or more of their premises. In the present context, the plausible option in this second camp is to take our arguments to be a *reductio* of the EMV approach to axiological uncertainty.[15] In this section, we comment on the degree to which this is a reasonable reaction.

First: *sometimes* the right reaction to a 'swamping' result is to read it as a *reductio*. It indeed does not seem, for example, that any arbitrarily low credence that it is sufficiently good to set cats on fire for fun should rule one's decisions, when one has credence well over 99.99999% that setting cats on fire for fun is extremely bad; so much the worse for any theory of axiological uncertainty that implies otherwise.

Second: the importance of relative stakes notwithstanding, there are in fact independent pressures to resist evaluative theories with precisely the expected-value structure, in cases involving extremely low probabilities of extremely high stakes. This point applies to empirical, as well as normative, uncertainty. For example, consider the following case (adapted from Bostrom (2009)):

> Pascal's mugging: A mugger approaches you. He has no weapon, but exhorts you to hand over your wallet: "In return, I will give you any finite amount of utility that you ask for. I'm able to do this because I have secret powers. Now, you might think it's extremely unlikely that I'm telling the truth here, but surely you have *nonzero* credence that I am; and if so, you only have to stipulate a sufficiently high utility reward, and then handing over your wallet will have positive expected utility for you."

Expected utility theory entails that one is rationally required to hand over the wallet in this case, provided only that one has *nonzero* credence that the mugger is telling the truth. But that seems wrong. The lesson is that expected utility seems to give wrong verdicts *in cases involving extremely high stakes and extremely low probabilities.*

Third: In the empirical case, however, it is *not* plausible to reject expected utility theory wholesale, in response to the case of Pascal's Mugging. It remains true that expected utility theory behaves well in general, including in cases that involve very (but not absurdly) low probabilities of very (but not absurdly) high stakes. Expected utility theory tells a very plausible story, for instance, about why it is rational to buy building insurance for one's main residence, despite believing that the chance one will ever claim on such insurance is well under 1%. If we seek to modify expected utility theory in response to Pascal's Mugging, therefore, we had better seek a relatively localised modification that

[15] The other option in the 'reductio' camp would be: a reductio of the claim that it is rationally permissible to have nonzero credence in the Total View. Since the Total View is both an extremely natural extension of a plausible fixed-population axiology, and is one of the handful of population axiologies that actually commands the assent of a sizeable minority of the theoretical community, however, this claim of rational permissibility strikes us as considerably more secure than the EMV approach to axiological uncertainty, so that this reaction is implausible.

mainly affects such *extreme* low probability-high stakes cases, not a wholesale rejection of the theory.

Fourth: Given the above comments, the salient question is whether the swamping results that we have discussed are more like insurance cases, or more like Pascal's Mugging (and the above example of setting cats on fire). The three relatively realistic decision scenarios we have discussed (Mere Addition, Extinction Risk, Space Colonisation) are more like insurance cases, and are crucially disanalogous to the example of setting cats on fire. For one thing, one's credence that it is extremely good to set cats on fire should be *extremely* low – well under 0.000001%, for instance. But given the state of play in first-order population-axiological theorising, an honest enquirer should not have such *extremely* low credence in the Total or Critical Level views (that credence should probably not be less than, say, 1%, however dim a view one is initially inclined to take of the Repugnant Conclusion). For another thing, the recommendations of the Total and Critical Level views *vis-à-vis the three relatively realistic decision scenarios we have analysed* are not actively repugnant; at most, they overturn rather mild contrary preferences of other theories or untutored intuitions. (Most people's *pretheoretic* intuition, for instance, is in fact that human extinction would be very bad, while adding extra persons and (relatedly) space colonisation strike most people as at worst neutral.)

Fifth: The Effective (Weak) Repugnant Conclusion, though, is a somewhat different story. Unlike the swamping results for empirically realistic versions of our decision scenarios, the EMV approach entails the Effective Weak Repugnant Conclusion even for an agent who has *arbitrarily* low (but nonzero) credence in Total and Critical Level views, and despite the fact that Repugnant Conclusions strike most people who are not sympathetic to Totalism as a first-order axiology as *strongly* repugnant. The 'swamping' result that leads to the Effective Weak Repugnant Conclusion, therefore, may be much more closely analogous to Pascal's Mugging, and hence it is much more plausible to read *this* result as a *reductio* of the EMV approach. Again, however, in the light of the dearth of worked-out, plausible extant alternatives to the EMV approach, this observation only really motivates seeking a relatively conservative modification of that approach, whose implications are limited to extreme low probability-high stakes cases. We should not too hastily conclude, that is, that the relatively mundane swamping conclusions discussed in the main body of our paper will also be casualties of this modification, any more than contemplation of Pascal's Mugging should incline us to stop insuring our homes.

Some readers, however, will already be inclined to read our main swamping results as *reductios* of the EMV approach, even without any appeal to any Repugnant Conclusion. While this raises a serious question of what the alternative approach to axiological uncertainty should be, this reaction does not seem unreasonable, and we have not argued against it. For those inclined towards this reaction, we therefore offer the following comments on what our paper has added to the pre-existing "swamping-based case against EMV". Others have previously noted (Ross (2006), Sepielli (2010), Beckstead (2013)) that such 'swamping' can occur at least when one theory assigns an *infinite* value-difference to some pair of alternatives, while a rival theory assigns a finite value-difference. In that case, any arbitrarily small (but finite) credence in the 'hysterical' theory would lead to swamping. To this basic observation, this paper adds, first, that the same phenomenon can occur with theories that postulate only finite value-differences (even for agents who again have

arbitrarily low credence in the relevant theories), so there is no prospect of avoiding the basic issue by ruling out "infinite value-difference theories" as somehow ill-formed. That this phenomenon is in principle *possible* is fairly obvious on reflection; second, though, we have shown that, in the case of population axiology, such 'swamping' under EMV is not merely an abstract possibility, but seems fairly likely actually to occur, for reasonable estimates of the relevant empirical parameters and for reasonable credence distributions. So the prospects for avoiding all finite-value-difference swamping in practice simply by having sufficiently low credence in the 'offending' theories also look fairly dim; if one wants to avoid swamping, the only escape route in the offing is rejection of the EMV approach to axiological uncertainty.

10. Conclusions

It has frequently been observed that in the context of population ethics in particular, we need to make decisions under conditions of moral uncertainty, including axiological uncertainty. Since even 'inaction' is in the relevant sense an action, we are forced to act now, and cannot simply wait until our uncertainty has been resolved.

At the theoretical level, at least one of the serious contenders for the effective axiology under axiological uncertainty is the ranking of alternatives according to their expected moral value (EMV). There has, however, previously been little investigation of what the EMV approach actually recommends, in the case of population ethics dilemmas. In this paper, we have established, for three different decision scenarios, that in an appropriately specified "large-population limit", the alternative that has the higher expected moral value is the one that is preferred by a particular critical level theory (where the identification of the critical level is determined by the agent's credences among Critical Level views, including the Total View itself). In this sense, Critical Level views 'swamp' all other extant rival population axiologies *in those large-population limits*. Depending on precisely how one fixes intertheoretic comparisons, there (further) seems to be at least some very real prospect that actual population sizes are large enough for this swamping to occur in practice, and not only in some counterfactual limit case.

The EMV approach equally entails the Effective Weak Repugnant Conclusion, which latter is likely to strike many people as strongly repugnant. If so, that is a reason to reject the EMV approach to axiological uncertainty in full generality; the Effective Weak Repugnant Conclusion is, structurally speaking, an axiological analogue of Pascal's Mugging. However, this consideration, as in the empirical case, motivates only a relatively conservative modification of expected value theory, and (because of that) is unlikely to provide any sound motivation for rejecting our more mundane swamping results. One might, however, read those more mundane results as a further reason to reject the EMV approach to axiological uncertainty across the board, and thus to postulate a deep structural difference between empirical and axiological uncertainty.

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