Indirect effects of population increases

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Overview

(1) Valuing an additional life-year at $100,000 seems like a reasonable order of magnitude, including for valuing additional lives created under a range of reasonable views in population ethics (Section 1). Thus, we use a $100,000 valuation in OP dollars as a default throughout much of the document. We discuss alternative population ethics in more detail in Section 5.

- We attach a modifiable spreadsheet where life year valuation and other important parameters discussed in this report can be changed.

(2) Simulations using a cohort-component model imply that adding 1 child can result in up to 1000 additional life years lived by 2600, even under conservative assumptions about future fertility. (Section 2)

- The additional life years increase the value of saving a life by between 5-10x, depending on (i) fertility rates (ii) for how long we expect this effect to last and (iii) assuming life years for contingent individuals are also valued.
- The quantity of additional life years varies substantially by current fertility rates: from 400 in low-fertility contexts to 1100 in high-fertility contexts.
- Our confidence in this effect is very high, to an order of magnitude.

(3) The positive spillovers (via innovation and market-size) likely outweigh negative spillovers (via the environment and animal products). (Section 3)

- The innovation and market-size effects could raise the value of an additional person by somewhere between $10,000-50,000 annually (so 10-50% of the intrinsic value OP places on a life-year). We are less confident about this than the demographic implications—it is difficult for researchers to generate high quality empirical evidence on these channels.
- Negative indirect effects seem either smaller in magnitude than the positive effects, temporary, or perhaps even alleviated by larger (and likely wealthier) populations.
  - For example, air pollution decreases with incomes past some point. So (i) the population-air pollution relationship is temporary and (ii) larger populations likely speed up this transition, implying small overall effects of additional air pollution harms.
- Animal product externalities are extremely difficult to say anything precise about. Most views regarding the value and experiences of animals make it unlikely that a majority of the intrinsic value of a person are offset. Likewise, the worst of these practices are also (hopefully) temporary and sped up by innovation and wealth.

Conclusion: Descendant life years is the indirect effect we are most confident exists and is most quantitatively meaningful. Under views of population ethics that our team finds most reasonable, this could lead to increasing the value of saving a life by about an order of magnitude. In terms of improving lives, we are not confident in the magnitude of the effect but historical evidence and economic theory suggest larger populations generate more well-being per capita, accounting for environmental costs. We discuss key open questions for further research at the end of document (Section 5), including how to value such effects under alternative views of population ethics.

1 Valuing life years for existing and contingent people equally

Before providing details we note that we use Open Philanthropy (OP) dollars throughout, such that the default value of an adult life year saved is equal to $100,000. These are roughly USD, as we understand it, putting these estimates in line with estimates of the value of a statistical life used by the US government and health economists studying US populations.

When valuing the creation of additional lives or life years in the future, we assume that the same value can be applied. In the economics literature, this approach is taken by Stanford's Pete Klenow and Chad Jones when valuing the increase in population during the last century (Klenow et al., 2022). In Section 5 we discuss how the takeaways of this report generalize to alternative assumptions. In the companion spreadsheet, the value of future lives can be reduced—to only partially inherit totalist implications—or increased—to account for the likely increase in the quality of life, depending on OP's preferences.

A related assumption used throughout the report is the non-replacement of infant deaths with new births (i.e., we assume that saving a life creates an entire counterfactual life). This is an important assumption, but easy to relax (and we allow for such a relaxing in the spreadsheet). For example, preventing a given miscarriage leads to zero additional life years if the parents successfully achieve their intended fertility afterwards. Preventing the death of a 10-year-old after a mother has left her childbearing years very likely produces many counterfactual years. The probability at which a death is replaced is difficult to estimate and will be context dependent as the examples above highlight. However, this term is multiplicative. If OP thinks there is a 0.5 chance of replacement for a given life being saved, all benefits can be scaled by 0.5.

2 Many more people exist as the result of a life-saving intervention

The expected number of descendants greatly impacts the expected number of life years lived from a given population change. If fertility rates are roughly two, so that every family replaces themselves, an additional person now means an additional person *forever.* If fertility rates are greater than two, as time passes there are ever-more additional people as a consequence of saving a life today. In countries with below two fertility, this effect shrinks in the long-run, but remains non-trivial in the coming centuries. Below we perform computational simulations to give a sense of the magnitudes of these effects given projections of fertility.

2.1 Future fertility is uncertain, but very likely below replacement

The population model we construct must take stances on fertility and mortality rates beyond where UN projections extend to. As a caveat: the goal here is to construct transparent scenarios, not necessarily quantitative predictions. The resulting model is a mash-up between near-term UN projections and long-run possibilities, with some discontinuities at 2100 where they meet.[1] Our assumptions are additionally chosen to mitigate the influence of our long-run fertility choices on the relevant outcomes, for conservatism. Our baseline assumption, for example, has fertility converging to lower levels (1.5) than the UN projections would imply[2], such that differences in population sizes shrink in the long-run (and therefore the level effect of adding a person today). This is in line with other long-run projections that we know of (e.g. Rennert et al., 2022).

The substantive reason for believing the future is likely to be one of low fertility is simply that there are no known policies or socio-economic forces that can reliably produce a rebound in fertility rates. The

[1]In future work we may try to smooth this transition, but we don't expect it to be critical for the final results.

[2]After 2100, each country's total fertility rate increases or decreases by 0.1 every 5-year period until converging to 1.5.

near-universal nature of low fertility makes it hard to believe that there are country-specific factors (policies, cultural norms, etc) driving this trend: the diverse contexts of the US, Russia, Brazil, Thailand, Nepal, Costa Rica, Switzerland and many others have TFRs between 1.5-1.8. Since 1950, 27 countries have seen completed cohort fertility fall below 1.9. None of these countries have ever since reported above 2.0 fertility, despite some of these governments attempting to reverse this trend.

The PWI-view of low fertility is that it is driven by opportunity costs. Globally, the utility per time/money spent raising kids hasn't improved nearly as much as the utility per time/money of the next best option for potential parents. It is not that kids are absolutely too expensive—which we could imagine alleviating—it's that they are *relatively* too expensive. That will only get worse with time as efficiency in other sectors evolves, unless there are truly unprecedented policy/technology/social changes that make parenting significantly more valuable per hour.

Looking as far into the future as we are, we cannot be confident that there will not be important developments of this sort. Perhaps some government does figure out a way to boost fertility and this investment has widespread uptake. Or perhaps there are improvements in technologies that allow parenting to become more capital intensive (e.g. artificial wombs that make pregnancy low-effort, automated cribs that lull babies to sleep at convenient times, better tablets and apps that keep children entertained in ways parents are happy with, etc). This could allow for efficiency increases that have thus far been absent in this "sector." An altogether different possibility that has been raised is that in a few hundred years the cultures and gene-lines with low-fertility preferences will shrink out of existence. The dominance of high fertility groups is something that's been proposed in the very long run (e.g. Kaufmann, 2010), but this reasoning is less robust than we think people recognize—and which we have written about (Arenberg et al., 2022)—especially over the next few centuries.

Finally, recall that higher fertility over the next few centuries implies that there is *more* to be gained from saving a life today than we document. Insofar as we are unduly pessimistic about future fertility, we are understating the knock-on effects. The modifiable spreadsheet allows for selecting different assumptions for long-run fertility rates so sensitivity can be explored by the user.

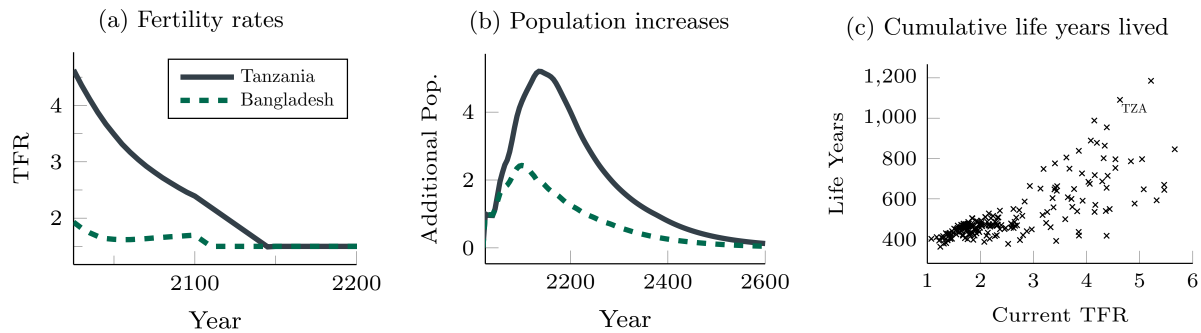
2.2 Cohort-component simulation of adding an additional child

Using the UN-model with our long-run assumptions, we perform quantitative simulations. The exercise adds one additional child aged 0-4 and compares population dynamics to the baseline case without this additional child. Figure 1 plots the relevant inputs and results for Bangladesh (current fertility rate of 2.0) and Tanzania (current fertility rate of 4.8). Panel (a) plots the background evolution in fertility rates in the respective countries through 2200 (after which it remains constant). Panel (b) plots the difference in population size in each country (and so by construction starts at 1.0 when the life is saved and grows once child-bearing years are reached for this individual). There are up to 5 additional people in Tanzania in a given year from this intervention, with a corresponding peak-response of just over 2 in Bangladesh.

Panel (c) summarizes the relevant finding by plotting cumulative life years lived as a result of a life-saving intervention; the x-axis is current TFR.[3] Each marker is one country. We include all countries in the UN data. In Tanzania, for example, an additional 1100 life years are lived between 2025-2600 if an additional child is saved (see the labeled coordinate at about (4.8,1100)). An additional Bangladeshi child results in about 450 life years being lived over this same horizon. Overall, in high-fertility countries, an additional

[3]Recall that these numbers can be scaled down by whatever probability put on the death being replaced (i.e., a 50% chance of replacement would scale the entire y-axis down by 50%).

Figure 1: Additional life years by TFR



Notes: Simulations of the effect of adding one child to different countries. Panels (a,b) compare Bangladesh and Tanzania as two representative countries of very different current fertility rates. Panel (a) displays assumed TFRs, where UN projections are used to 2100, where after we assume they converge to 1.5. Panel (b) displays the difference in expected populations size resulting from a one-child increase in 2025. Panel (c) plots cumulative life years lived between 2025-2600 for an additional child today for all countries in the UN data. The x-axis is current TFR. The coordinates (1.5, 400), for example, implies that for a country with current TFR of 1.5, when we run the a counterfactual with one-additional child in 2025, has 400 additional life years lived through 2600 after counting their life and their descendants.

child today causes many more life years to be lived over the next two centuries than an additional child in a low-fertility country.

One thing not done in this simulation is to allow others' fertility choices to respond to the larger population. For example, consider a Malthusian world where resources constrain the total population size. An additional birth must be offset by a death or the absence of some other birth. Alternatively, if family choices are constrained by wealth, and the additional person increases per capita income (as we argue below), then saving a life may have positive population spillovers beyond just their descendants. Gustav Alexandrie and Maya Eden of the Global Priorities Institute have some preliminary work on this topic[4], wherein they conclude that standard theories of fertility imply that contemporaneous population "shocks" can have long-run effects on lives lived (as happens under our assumptions when the population is shocked by 1 person). Therefore, the most reasonable baseline assumption, in our view, is that social fertility rates are invariant to the small changes in population size we study.

In sum, the additional life years lived from an exogenous population increase is significantly greater than the initial impact. This is true in all contexts, but especially so in places with high fertility today. **This is the most significant effect in this report, and would cause us to scale the benefits of saving a life by 5-10 times**, depending on how significantly Open Philanthropy wants to discount the effects (for epistemic or existential reasons).

3 Innovation spillovers likely outweigh negative spillovers, but imply a smaller benefit than descendants

Aside from the additional human life years lived, there are multiple sources of externalities people have on one another. The biggest seem to be: innovation and agglomeration externalities (positive), and environmental

[4]It will be an upcoming chapter in the Global Priorities Institutes *Essays on Longtermism.* Interestingly, the thesis of their essay is that saving near-term lives may be as cost-effective as reducing existential risk if we (reasonably) expect contemporaneous population size to influence the population size into the long-run future.

externalities (negative). Our reading of (i) history, (ii) the economic theory literature and (iii) our own research suggests the positive externalities dominate, implying that an additional person benefits other people on net. Negative externalities on animals may be important in the near-term, but are difficult to say anything precise about because researchers have not yet produced a body of credible, quantitative inputs needed for such an evaluation.

3.1 Agglomeration and Innovation

Agglomeration effects arise in settings where fixed costs are important. That is, there are some costs that do not depend on the quantity of production (say, the initial design and construction of a bridge connecting two cities). In the presence of fixed costs—because they can be spread among more people—large populations have higher living standards. Paul Krugman was awarded the Nobel Prize for showing that increasing returns to scale (coming from such fixed costs) were necessary and important in explaining spatial patterns of economic activity and trade—indirectly suggesting that large populations, in general, will be more productive.

A related insight of equal or greater importance—garnering Paul Romer the Nobel Prize—is that ideas are non-rival. This likewise implies that a larger economy will generate higher per-capita living standards. The chain of logic is simple, so we sketch it out here. Consider two uncontroversial claims:

1. The production of ideas is increasing in economic activity/resources (i.e., ideas are like any other good: more inputs implies more output).
2. Ideas are *non-rival*; that is, once discovered they can be simultaneously used by everyone at once.

Putting these together: a larger world generates more ideas, and these ideas benefit everyone. We at the PWI are compelled by this logic. And insofar as innovation has been the engine of progress, we think this positive effect of larger populations will be a decisive feature that leads to per capita well-being increasing in populations. To quote from a review article by Chad Jones and Paul Romer (2010, p. 231) summarizing progress in academic macroeconomics:

> *In practice, urbanization, increased trade, globalization in all its forms, and the positive trend in per capita income all point in the same direction. In the long run, the benefits of a larger population that come from an increase in the stock of available ideas decisively dominates the negative effects of resource scarcity. In such a world, any form of interaction that lets someone interact with many others like her and share in the ideas they discover is beneficial, and the benefit need not be exhausted at any finite population size.*

Below we make attempts to quantify this.

3.1.1 A simple analytical framing

Consider adding an additional person, now and forever, to a population of initial size P_0. Call ϵ the long-run population-income elasticity, such that a permanent 1% increase in the population leads to a long-run increase in per-capita incomes of ϵ%. Furthermore, we will value a log-increase in income at \$50,000, regardless of income, such that these gains are in terms of OP dollars. Then we can value the annual benefits of an additional person as the per-capita log-increase in income, valued at \$50,000, for each of the P_0 people in that population:

$$ln\left(\frac{y'}{y_0}\right) \times 50,000 \times P_0,$$

where

$$\overbrace{100 \times ln\left(\frac{y'}{y_0}\right)}^{\text{\% change in income}} = \overbrace{100 \times \frac{1}{P_0}}^{\text{\% change in pop.}} \times \epsilon,$$

subbing in implies:

$$ln\left(\frac{y'}{y_0}\right) \times 50,000 \times P_0 = 50,000 \times \epsilon.$$

This simplifies to $50,000\times$ the long-run population-income elasticity, ϵ. The size of the population in question is irrelevant as it scales down the percent change by the same factor it scales up the number of people benefited.

Surprisingly little work has been done to estimate ϵ. Peters (2022) is an important exception. He directly attempts to estimate this parameter using exogenous changes in long-run (local) populations and finds an ϵ of 0.5-0.7. The setting he uses to identify the causal impact of population on incomes is the (quasi-)random refugee assignment in post-WWII rural Germany.[5] By asking whether localities that were assigned more people ended up wealthier, his estimates capture the all-things-considered elasticity. This includes: the effect of local-knowledge (and adoption of external technologies), agglomeration effects (i.e., market-size and gains-from-trade effects), and even the loss from sharing fixed local farmland and resources across more individuals. Helpfully, the setting of poor and rural post-WWII Germany has many similarities with current rural Sub-Sahara Africa. This is the most direct and relevant estimate of the population-income elasticity that we know of, so we place a high weight on this value in the exercises below.

At the same time, we recognize it is only one empirical paper in a world where results frequently fail to replicate. A high-level, more holistic view, as noted by the Jones and Romer quote above, also supports such a channel. In Eden and Kuruc (2022) empirical estimates from a similarly well-vetted empirical paper, *Are Ideas Getting Harder to Find* by Stanford and MIT economists (Bloom et al., 2020), are used to infer what such a long-run elasticity of population changes would be in a global ideas-based growth model. The central estimates of Bloom et al. support an ϵ of $\approx$0.33.[6]

Hedging between these two estimates, take 0.5 as ϵ. Then the long-run effect of a population that is 1 person larger is roughly $25,000 (OP dollars) per year, or 25% more than OP currently values a person-year. These estimates could be scaled down because these benefits take decades to fully accumulate. But they could be scaled up because in practice increasing the population by 1 child today increases long-run populations by more than 1, increasing the total long-run income effect. **Anything between a 10-50% increase in the valuation of saving a life seems appropriate through this channel.**

[5] Eastern European countries were expelling German refugees who had fled the country *en masse* before the Allies quickly figured out a system of (quasi-random) assignment. Peters argues the only reason to expect differences in long-run incomes from this scheme are the population differences, after some initial conditions are controlled for in the statistical exercises.

[6] The Peters (2022) estimate is larger in part because it also captures other agglomeration benefits alongside the new ideas.

3.2 Negative spillovers are likely smaller in magnitude, and context contingent

Here, we explain why we believe the negative spillovers are smaller in magnitude, leading to a positive overall effect of population on average incomes. One reason is *contingency.* The effect of population on carbon emissions, industrial animal production, air pollution, etc., are dependent on current practices and technologies. We expect them to only persist for a share of the line of descendants, whereas models with a positive income-population relationship suggest this is a deep and persistent relationship.[7] Furthermore, the additional income and innovation of larger populations may speed up the elimination of these harmful practices, making the effect of additional people ambiguous (this is discussed in detail in Section 5 as an important open question).

3.2.1 Climate change has limited effects because of timing

Climate change has limited relevance for this question. Kuruc et al (2022)[8] show this in quantitative detail for the case of fertility rates. The takeaway from that paper is that *population momentum* makes the pass-through from fertility rates to climate change very small. Population is a stock that takes many years to change via fertility rates; a 1% change in fertility does not lead to a 1% increase in the total population for many decades. By the time large differences in populations arise, the total share of all historical emissions already emitted will be large, leaving little room for fertility rates to influence long-run temperatures.[9]

The setting here is importantly different: saving a life changes the population now. Again for simplicity let's imagine roughly replacement fertility rates such that an additional person now is an additional person forever. The population momentum logic still (roughly) holds.

This new person, if saved today as a child, will be non-working for the first 20 or so years of their life; their peak productivity will be 30-50 years from now. Until they are productive members of society their emissions contribution will be negligible according to standard macroeconomic models. By consuming without producing, a child merely rearranges resources (in practice parents save or consume less themselves).[10]

In the case of the developed world, which may be mostly decarbonized by 2050, an additional child today is likely to have a very limited carbon footprint, not to mention all of the descendants of this person. Forecasting emissions trajectories in less developed economies comes with more uncertainty. No matter the exact path of emissions, this effect ought to remain an order of magnitude smaller than the positive spillovers outlined above. In the companion spreadsheet we show that even pessimistic guesses of the additional emissions—valued at OP's social cost of carbon—lead to only small changes in the final valuation.

Before moving on, there is an important way in which population can be an environmental *benefit* when considering climate change. Once emissions intensities fall to near-zero, the climate challenge will involve removing emissions from the atmosphere. The stock of greenhouse gases in the atmosphere will, by then, constitute a fixed cost. By analogy, what we're doing now is leaving a pile of dirt for our descendants to shovel. The size of this pile will be mostly determined this half-century, but the number of people available

[7] Though some believe AI may mute this relationship if it is sufficiently scalable and substitutable with humans in the innovation process.

[8] Not available online yet, but circulated privately to Open Philanthropy and available upon request.

[9] Even in a world where there decarbonization has not advanced by 2100, so many emissions will have been spent by 2100 that the *share* coming after 2100 cannot be too large.

[10] Though they could also respond by working more to offset lost consumption, which would be a channel by which children do lead to more production. We do not know this literature in detail. It seems that, at least for mothers, working hours fall after child-bearing. As another relevant aside, standard models imply that savings are routed to firms who want to invest in capital. So it is another mistake to think that saving rather than consuming is necessarily eco-friendly—saving (at least through financial institutions) lowers the cost of capital and incentivizes more investment.

to shovel next century will make the challenge dramatically easier or harder. This goes for other climate adaptations such as sea walls or relocating population centers. It is difficult to know how to quantify this; the cost of removing emissions in the future is unknown. What will be true is that the per-capita cost of removing a fixed number of emissions will be smaller under a larger population.

In summary, a new person today does not substantially contribute to emissions until 2050 or so. Even in now-developing regions it is likely that decarbonization efforts will be underway by this time. Even if one grants that emissions will be substantial through 2100, that leaves roughly 50 years of emissions that this entire lineage will produce; this is going to be trivial relative to the other costs and benefits discussed in this report. In fact, because transitioning to green energy and generating negative emissions requires fixed costs, on balance the climate effects of an additional person may even be positive. This last statement is extremely speculative. But **we are reasonably confident that there are not large *ex-ante* negative effects, relative to the benefits of population.**

3.2.2 Non-renewable resources do not seem crucial

A larger population will use up non-renewable resources—such as fossil fuels—faster. We suspect this is approximately welfare-neutral and therefore something to be ignored in calculating the externality of an additional person, owing to arguments by Greaves (2019) and Lawson and Spears (2018). Consider the case where we do not manage to invent a substitute for a given non-renewable resource that is necessary for human flourishing. For a given per-capita level of use for this resource, the total number of humans who ever live is constrained. Extending humanity's chronological existence is welfare-neutral under most views if done via smaller annual populations ("population-spreading," as Greaves calls it).

More positively, it seems very unlikely such a non-renewable resource constraint is truly binding. Then, the question is whether we can invent and deploy substitutes before we run out of said resource. In this case, additional people increase both the use of the resource, but also the probability a substitute is invented. Under plausible versions of models with both features, they will offset, again implying welfare-neutrality of population sizes via this channel.

3.2.3 Air pollution, renewable resources, etc. have mixed, but relatively small, effects

Finally, there is the issue of renewable resources (land, air quality, fresh water, timber, minerals, biodiversity, etc). Some of these are fully "renewable" each period (e.g., minerals that are continually used or recycled into new products), some only partially regenerate (fish, timber, biodiversity, etc). Despite their prominence in many debates over the years regarding population size, there has not been decisive progress in the economics literature valuing how bad it would be to spread these resources amongst more people.

Eden and Kuruc (2022) attempt to quantify the innovation benefits noted above against the income-effects of reducing renewable resources per capita. Following a tradition of economists who have studied this issue, they point to market prices as evidence for a low pass-through from marginal increases in these resources to well-being. Lam (2011), in his presidential address to the Population Association of America, recounts famous debates between Paul Ehrlich and Julian Simon. The two men placed bets on how the prices of fixed resources would would evolve as populations grew. If, as Ehrlich believed, these resources placed severe constraints on human well-being, their price would dramatically increase as populations and competition for these resources increased. Ehrlich lost. Prices for minerals, food, etc. fell as populations grew over the last half-century.

The past does not offer proof that no such constraint will eventually bind. But the Ehrlich-Simon lesson persists: the argument in Eden and Kuruc (2022) is that the share of global income going to owners of natural resources is too small for these resources to be importantly binding, on the margin.[11] Based on global price and quantity data for natural resources, they take -0.1% as a conservative value for the elasticity between populations and incomes coming from spreading renewable resource use among more people (recall, this 0.1% loss is significantly smaller than the 0.5-0.7% gain estimated by Peters (2022) and even the 0.33% implied by idea-based models calibrated to empirical findings). We use this as the baseline value in the attached spreadsheet.

There are many non-market goods necessarily omitted from such an argument (biodiversity, air quality, etc). However, these in particular seem subject to a Kuznets-like relationship.[12] As incomes go up, societies appear willing to put more regulations on biodiversity preservation and many forms of local pollution (air, water, etc). So a larger population has competing effects: more people have more resource needs and waste, but also increased incomes, which decreases per capita environmental stressors. On net, there is a high likelihood that these constitute a negative effect, but it would be surprising to us if they were quantitatively meaningful. For example, on the companion sheet, even if we assume the relationship between pollution and deaths persists indefinitely, that would only lead to a 1-5% decrease in the value of the intervention.

3.2.4 Externalities on animals are potentially large, but also contingent

The additional human life years have implications for the number of animal life years lived. Wild animals will be crowded out, but more farmed animals will live.

An important thing to note is that a similar context-contingent argument applies here, especially for industrial farming. Consider again Figure (1b). In a country with above replacement fertility rates, most of the additional life years coming from a life-saving intervention are lived beyond 2100. It seems reasonably likely that alternatives to industrial farming exist by this point. If so, only a relatively small share of the life years coming from this population change contribute negative value through this channel. Considering OP's current estimates of the meat-eater problem, this further fact makes it likely this channel is negligible when considering longer horizons. A related point is that this negative externality gives rise to important complementarities in OP's giving. To the extent that farmed animal activism reduces the pass-through from population to animal suffering, gains on this front further increase the value of life-saving interventions.

Beyond this, we largely agree with the range of important work in progress on the implications of larger human populations for farmed and wild animals, including the deep empirical and normative uncertainty surrounding these valuations. OP's current work on the population-meat-eater problem, in particular, seems to do an excellent job cataloging the current empirical relationships. The uncertainty about the evolution of these markets, as well as the value of these lives, is uncertainty we share, despite taking some initial steps towards attempting to monetize animal life years (Budolfson and Spears, 2019, 2020; Kuruc and McFadden, 2022).

Regarding wild animals, the marginal number and species which exist over time from a larger human

[11] Note that the pricing argument works for expected future scarcity as well: if financial markets anticipated these resources would eventually command high prices, investors would bid up the price now (specifically, as long as the expected price increase exceeded the returns of other financial assets).

[12] Meaning the relationship takes an upside down U-shape. Consider air pollution: extreme poverty leads to almost zero air pollution (due to the lack of production and consumption); as incomes increase air pollution rises (think of developing South Asia); when sufficiently wealthy though, countries pay to reduce air pollution (think of the developed countries, and even cities like Beijing recently reducing air pollution.

population are even less empirically tractable. Whether their lives produce positive value is also the subject of considerable debate (see e.g., Browning, 2021; Groff and Ng, 2019). For both of these reasons, we do not attempt to value them in this report.

4 We ignore dependency effects because they rely on population growth rates

The intervention of saving a life does not persistently change the age structure of the population. A saved person moves through every age. More generally, it is the population growth rate, rather than its size, that influences dependency-channels. Some prominent economists, such as Galor (2022), have argued that low fertility may in fact be a boon for humanity, coming from dependency-adjacent benefits. Galor and others are focused on educational investments, which they believe will further increase in regimes of population decline (because there are few children, to whom we can collectively afford to give large investments). Whether or not that argument is correct,[13] it is somewhat misplaced for the counterfactual here: the child:adult ratio is only temporarily changed at the time of the saved life.

The more common version of dependency concerns are about social security and pensions systems (wherein the working age population is small relative to retirees). This concern works in the opposite direction of the educational benefit—low fertility implies many retirees per working age adult. One may take this to be an argument that saving a person in a place with low fertility has an advantage along this dimension. Things are more complicated. Consider a child in a country with an unfavorable dependency ratio, such as South Korea. On impact, this actually makes the problem *worse*: along with the old people not contributing, a young person is added who also does not contribute. After 20 years or so, this person makes the ratio more favorable, until they have children of their own. The effect is not precisely zero, but as long as fertility rates are not persistently changed, it will be small enough that we expect it can be ignored.

These growth rate effects would be important and deserve further study if Open Philanthropy were to consider interventions to make parenting easier, for example.

5 Especially important further research areas

5.1 Generalizing this analysis to alternative population ethics

The document has thus far taken a totalist-adjacent point of view. A simple alternative is to discount the life years of individuals who do not yet exist. The spreadsheet we provided has a cell that allows for plugging in different value (including $0).

Widely considered alternatives—averagist views and person-affecting views—are somewhat difficult to make sense of here, and may require further research before being applied. First, consider views with an averagist component. We do believe that the incomes of all individuals are increasing, on average, in population sizes (owing to the arguments in Section 3). That does not imply that global per capita GDP is higher in a world where someone in Sub-Shara Africa is saved. This is because the composition of the world population changes; Sub-Sahara Africa receives a higher weight in such calculations. It can at the same time be the case that every country has counterfactually higher per capita income, but because of this composition

[13] We happen to disagree with the takeaway for reasons beyond the scope of this report.

change average well-being is decreased (especially if additional farmed animals are counted). We have not yet studied this trade-off quantitatively, as we do not yet have a full cross-country model accounting for the costs and benefits of population changes.

Different complications arise if one takes a person-affecting view—one where we do not value the life years or utility gains of people who only exist because of this intervention. First is the well-known non-identity problem; we are uncertain who's existence is contingent and so who's utility gains should count. The second regards animal products. Are we to not count the negative value of those lives because they are also contingent on the intervention? And if an asymmetry is applied and only negative lives are counted, the deck may be stacked against creating anyone (because we would count all of their descendants' animal consumption, without counting the benefit of the descendants existence).[14]

In short, non-totalist views seem very difficult to apply to such a case, at present. Furthermore, recent research at PWI suggests that more realistic extensions of population ethics—to coherently include animals Zuber et al. (2022), to consider cases with already existing background populations (Spears and Budolfson, 2021; Spears and Stefánsson, 2022), etc.—suggests that such extensions make the case for totalist-adjacent population ethics stronger than currently recognized.

5.2 Population time vs. calendar time

A subtle distinction that may importantly influence the welfare effects of new people is between population time and calendar time. This distinction was hinted at in the discussion of non-renewable resources (where "population spreading" was considered welfare neutral if the same number of people ever exist, but over longer horizons). This concept may apply to more cases. We believe this is point is new to this document and deserves more rigorous investigation before anything conclusive is said.

Consider again industrial farming, where additional people both consume animal products but speed up the expected date that a given alternative (say, lab grown meat) exists. Using the Chad Jones model of innovation, it is (approximately) the cumulative historical people-years that determines the level of technology. In this case, no matter the timing of when people live, the same exact number of people-years (and therefore consumption years) exist in statistical expectation before lab grown meat exists. If correct, there are near-zero animal product externalities from larger populations, regardless of the weight on animals or the conditions under which they exist.

This logic cuts both ways. To speed up any invention through population changes, more people need to exist now, before the invention happens. This again offsets the speed at which the invention happens: the same number of expected people-years exist before any good invention, regardless of the annual size of populations. The non-zero welfare-effects come on the back end. By inventing something earlier in calendar time (say 2050 rather than 2100), more of these better people-years are lived after this invention.[15] This general line of inquiry regarding population vs. calendar time is underexplored and seems potentially important for valuing larger contemporaneous population sizes. This is something Kevin Kuruc is planning to make progress on this coming academic year and would be happy to update OP on progress if this is of interest.

[14] Along with the more standard worry that if only negative existences are counted, any small risk of experiencing a negative existence would recommend against creating anyone (because the positive counts for zero, so why risk any negative value?).

[15] Of course, things get more complicated if extinction risk is explicitly modeled as a function of technology and/or contemporaneous population size.

5.3 Generalizing innovation models to multi-country settings

Despite the theoretical robustness of the argument that larger populations have positive agglomeration and innovation benefits, cross-country applications of the sort relevant here are absent in the academic literature. The populations increased through OP's life-saving interventions are not frontier countries where most innovation takes place. It is an open question how important it is *where* new people exist. For example, if population growth in developing countries allows frontier countries to outsource more manufacturing and increase their knowledge sectors, this population growth would enhance innovation. Perhaps by nearly as much as population growth in frontier countries themselves. Kevin Kuruc and Marta Prato (a PWI affiliate) are in the early stages of modeling heterogeneity in the innovation process to make quantitative progress on this. Recall that the Peters (2022) estimate of long-run population-income relationships that we use relies on local benefits, so at present we may be ignoring an important source of global benefits through this channel.

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