HIGH SCHOOL EDITION
Journal of Student Research
Volume 14 Issue 1 (2025)

The Optimal Global Population: An Economic Analysis

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ABSTRACT

The global population recently surpassed 8 billion, reigniting old debates about the optimal population size. These debates are not merely interesting, but have important implications, especially in an era of growing concerns about climate change and the unsustainable depletion of natural resources. Yet though the question of population size has been explored within diverse fields, from philosophy to biology, few have attempted to address it through the lens of economics. Given that economics studies human behavior as a relationship between given ends and scarce means and that scarce means are generally agreed to be the primary limiting force on population size, the discipline has the potential to offer valuable insights regarding population optimization. This paper explores that potential by applying principles from the field of economics in assessing the optimal global population size. Specifically, it draws on the economic concept of utility maximization, examining four specific measures of utility—short-term total utility, long-term total utility, short-term per-capita utility, and long-term per-capita utility—and assessing what population size would maximize each. It concludes that while the optimal population has not yet been reached in terms of short-term total utility, in terms of the other three measures it has already been surpassed—in some cases, significantly. However, it acknowledges the optimal population size is not a fixed number but rather depends highly on largely exogenous factors, such as technology and lifestyle choices. It also warns against the rash adoption of policies to aggressively bring the global population to a perceived optimal level.

Introduction

In November 2022, the global population surpassed 8 billion, and it is projected to reach 10.4 billion by the end of the century before leveling off.[1] Some view these figures with concern, arguing that the planet is becoming increasingly overpopulated. Yet others have expressed fears that the population isn't growing quickly enough. So what is the optimal population, and have we already reached it? It's a question that is not merely interesting, but one with important implications, especially in an era of growing concerns about climate change, environmental destruction, and the unsustainable depletion of natural resources. As founder of the Optimum Population Trust David Willey aptly asserted, "reaching the optimal global population may not solve all of the world's problems, but it would "make them solvable," and achieving a consensus about the size of that population would represent "an important step towards achieving it."[2]

Willey, like many of those who have investigated the question of optimal population over the years, was a philosopher. Others, like Paul Ehrlich, author of the influential book *The Population Bomb*, have had backgrounds in biology.[3] Yet relatively few, at least in recent years, have attempted to approach the question through the lens of

[1] Walsh, Bryan. "Are 8 billion people too many — or too few?" *Vox*. 4/19, 2023. https://www.vox.com/the-highlight/23436211/overpopulation-population-8-billion-people

[2] Willey, David. "An Optimum World Population." *Medicine, Conflict and Survival*, vol. 16, no. 1, 2000, pp. 72–93. JSTOR, http://www.jstor.org/stable/45351750.

[3]Jowit, Juliette. "Paul Ehrlich, a prophet of global population doom who is gloomier than ever." The Guardian. Oct 23, 2011. https://www.theguardian.com/environment/2011/oct/23/paul-ehrlich-global-collapse-warning

economics. Economics may not seem like a subject with obvious relevance to the question of optimal population size. However, as the prominent economist Lionel Robbins defined it, economics is "the science which studies human behavior as a relationship between given ends and scarce means which have alternative uses." And given that population is a product of human behavior and that "scarce means" are generally agreed to be the primary limiting force on population size, the field of economics has the potential to offer valuable insights regarding population optimization.[4]

This paper will explore that potential by applying principles from the field of economics in assessing the optimal global population size. The term "optimal" is used often in economics, and generally refers to the "very 'best' possible situation or state of affairs according to some explicit objective that provides a precise standard of evaluation."[5] Yet what explicit objective should be used to judge optimality when it comes to population size? To answer that question, this paper embraces the concept of utility, which economists generally define as the "satisfaction that a consumer experiences from a product or service."[6] In the case of population, that product or service is life, so utility can be interpreted, albeit crudely, as the value derived from life. This paper will examine four specific ways of thinking about value derived from life—short-term total utility, long-term total utility, short-term per-capita utility, and long-term per-capita utility—and assess their implications in terms of optimal population. It concludes that while the optimal population has not yet been reached in terms of short-term total utility, in terms of the other three measures it has already been surpassed—in some cases, significantly. However, it acknowledges the optimal population size is not a fixed number but rather depends highly on factors that are largely exogenous, such as technology and lifestyle choices. It also warns against the rash adoption of policies to aggressively bring the global population to a perceived optimal level.

Discussion

Short-Term Total Utility

The total utility of a population in the short term can be expressed as the summation of the individual utilities of everyone alive. Theoretically, total utility can be improved through an increase in either the size of the population or an increase in the average utility of the current population. However, because resources are finite, there exists, at least after a certain point, a trade-off between the two. An increase in population, ceteris paribus, means fewer resources available per person, and consequently, a lower average utility. Given this trade-off, the total utility maximizing value of population may not be readily apparent. However, it is important to note the law of diminishing marginal utility, which holds that with any increase in consumption, "the marginal utility derived from each additional unit declines."[7] Therefore, to maximize total utility within a resource-limited world, it is better to spread those resources over a larger number of people than to cluster them in the hands of a few. As a result, the utility maximizing population size will generally be the largest population that the planet's resources are able to support. So what is the largest population that can be supported with the resources currently available on earth? Estimates vary widely. However, by definition, the number of people our planet could support in the present must be at least as high as the number it is currently supporting. One credible recent study found that under existing technologies our current agricultural land could

[4] "What Is Economics?" The Library of Economics and Liberty. https://www.econlib.org/library/Topics/College/whatiseconomics.html
[5] Johnson, Paul. "Optimum." Auburn University. https://webhome.auburn.edu/~johnspm/gloss/optimum.phtml
[6] The Investopedia Team. "How to Measure Utility in Economics." Investopedia. August 23, 2021. https://www.investopedia.com/ask/answers/042015/what-are-different-ways-utility-measured-economics.asp
[7] Kenton, Will. "The Law of Diminishing Marginal Utility." Investopedia. May 4, 2024. https://www.investopedia.com/terms/l/lawofdiminishingutility.asp

support nearly 20 billion people, far more than it currently holds.[8] Therefore, it seems likely that increasing the global population would yield higher short-term total utility.

Long-Term Total Utility

Like short-term total utility, long-term total utility can be expressed as the summation of the individual utilities of everyone alive, and given the law of diminishing marginal utility, this value can be maximized by achieving the largest possible population. However, in the case of long-term total utility, there is an added temporal element. If a level of population is not sustainable in the long-term, it cannot be considered utility maximizing by this definition. To maximize long-term total utility, we must therefore seek to find the largest population that can be supported indefinitely, a figure often referred to as the planet's carrying capacity. Currently, there is fierce debate over what that is. A recent review of 65 studies found an enormous range of figures, from as low as 500 million to over a trillion.[9] However, the majority of studies determined that the carrying capacity is somewhere between 4 and 8 billion, substantially less than the earth could theoretically feed in the short term.[10] This makes sense because many practices that boost short term production, such as overfishing and excessive use of pesticides, have harmful environmental impacts, which could render the planet less hospitable to human life in the long term. Indeed, the researchers who arrived at the 20 billion estimate also warned that reaching this level might "wreck the planet."[11] Also, as the population approaches the limit of what can be sustained, there is more risk of competition for resources leading to violent conflict, such as war.[12] That would be extremely costly, as a major global war would likely lead to the deaths of billions and a decline in the quality of life for those who survive, meaning a significant reduction in long-term utility.[13] Therefore, it seems likely that the optimal global population in terms of long-term total utility is lower than the current population.

Nevertheless, in assessing the optimal population, it is important to keep in mind that these estimates are highly dependent on productive capacities, which are prone to change in the long-term. In 1798, political economist Thomas Malthus predicted that the population would soon surpass "the power of the earth to produce subsistence for man," and that the necessary consequence would be "premature death."[14] Yet the human population has grown eightfold since then, and his prophecies of gloom and doom have not come to pass.[15] Malthus was wrong primarily because he failed to foresee how improvements in technology would allow humans to produce more with less labor, dramatically increasing the number of human beings the planet would be able to feed.[16] And if technologies continue to

[8] Cuff, Madeleine. "Farmland could feed 20 billion people but it might wreck the planet." NewScientist. April 10, 2023. https://www.newscientist.com/article/2368195-farmland-could-feed-20-billion-people-but-it-might-wreck-the-planet/

[9] "How many people can Earth actually support?" Australian Academy of Science. https://www.science.org.au/curious/earth-environment/how-many-people-can-earth-actually-support

[10] Ibid.

[11] Cuff, Madeleine. "Farmland could feed 20 billion people but it might wreck the planet." NewScientist. April 10, 2023. https://www.newscientist.com/article/2368195-farmland-could-feed-20-billion-people-but-it-might-wreck-the-planet/

[12] Koren, Ore. "Food, Climate Change, and War in the 21st Century." Georgetown Journal of International Affairs. March 7, 2022. https://gjia.georgetown.edu/2022/03/07/food-climate-change-and-war-in-the-21st-century/

[13] Skolnik, Jon. "Here's How Nuclear War Could 'Destroy Civilization' in Just a Few Hours." Vanity Fair. March 26, 2024. https://www.vanityfair.com/news/how-nuclear-war-could-destroy-civilization

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[16] Shermer, Michael. "Why Malthus Is Still Wrong." Scientific American. May 1, 2016. https://www.scientificamerican.com/article/why-malthus-is-still-wrong/

improve, the optimal human population could continue to grow. For instance, developments in renewable energy for sustainable agriculture could enable humankind to produce more, and thereby support a greater population at a higher standard of living, without causing irreparable damage that jeopardizes the long-term survival of humans or other species. Therefore, even if our current population likely exceeds the planet's carrying capacity based on our current technological capabilities, it is not unfeasible that technological advancements could raise the carrying capacity to well above the 4-8 billion range established.

Short-Term Per-Capita Utility

One of the problems that arises when defining the optimal population as one that maximizes total utility, either in the short- or long-term, is that, as we have observed, it prioritizes quantity of life over quality of life. As philosopher Derek Parfit observed, "for any possible population. . . all with a very high quality of life, there must be some much larger imaginable population whose existence, if other things are equal, would be better even though its members have lives that are barely worth living."[17] Parfit referred to this as the repugnant conclusion, as it results in an outcome that many would view morally repugnant, and it has been the impetus behind many calls for alternative definitions of optimality.[18] One obvious way to avoid the repugnant conclusion is by defining the optimal population as one that maximizes per capita utility rather than total utility. This means that the optimal population is not the largest one that the planet can support, either in the short- or long-term, but rather, the population that will provide the best quality of life for those it does support.

To determine this number, it is helpful to first establish a clearer metric for quantifying quality of life. Perhaps the most obvious candidate for this task is the Human Development Index (HDI). Designed as an alternative to its growth-centric predecessors, the HDI is widely used as a proxy for quality of life, measuring achievement in three key domains of human development—health, education, and standard of living.[19] Even though the HDI is typically used to evaluate the quality of life of populations within a country or region, it could nevertheless provide a reasonable framework for estimating average quality of life on a global scale. Next, we may consider how the three domains included in the HDI behave in response to changes in population. In this matter, there appears to be a high degree of variability. When population size is low, it has been observed that increases in population are more likely to lead to gains in the HDI.[20] One reason for this is that a population that is too small might lack sufficient diversity of skills, leading to economic inefficiencies and reduced access to specialized services. However, when population size is high, it has been observed that increases in population are more likely to reduce achievement in the HDI.[21] This may be because when a population is already approaching its carrying capacity, there is generally more competition for scarce resources, limiting living standards and health. In such situations, reducing the population can ease the strain on carrying capacity and improve the well-being of populations. For example, it has been observed that following the Black Death, which may have killed nearly half of people in Europe, those who survived experienced higher wages and greater access to food and clothing, and even tended to live longer lives than those who had lived before the plague.[22]

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[17] Arrhenius, Gustaf et al. "The Repugnant Conclusion." The Stanford Encyclopedia of Philosophy. https://plato.stanford.edu/entries/repugnant-conclusion/

[18] Ibid.

[19] "Human Development Index." United Nations Development Programme. https://hdr.undp.org/data-center/human-development-index#/indicies/HDI

[20] Xu, D. "On the relationship between population and economic development." Renkou Yanjiu. https://pubmed.ncbi.nlm.nih.gov/12159284/

[21] Xu, D. "On the relationship between population and economic development." Renkou Yanjiu. https://pubmed.ncbi.nlm.nih.gov/12159284/

[22] DeWitte Sharon. "Mortality risk and survival in the aftermath of the medieval Black Death." PLoS One. 2014 May 7;9(5):e96513. doi: 10.1371/journal.pone.0096513

Therefore, per-capita utility by population size would likely be increasing at low levels of population and decreasing after the population surpasses a certain mark, with that inflection point representing the optimal population. While the precise value of that inflection point may be impossible to determine, it will almost certainly be lower than the population that maximizes total utility in both the short term and long term. That's because when competition for resources has reached such a level that the planet simply cannot sustain more life in the short term or even in the long term, it will likely have already begun to interfere with determinants of a quality life, like living standards and health. This means that, from a perspective of short-term per-capita utility, we have likely exceeded the optimal population, potentially by a significant margin.

Long-Term Per-Capita Utility

Defining the optimal population as the one that maximizes short-term per-capita utility may resolve the issue of the Repugnant Conclusion, but it is still prone to limitations. In particular, like short-term total utility, it completely ignores the issue of sustainability. This is problematic because maximizing short-term per-capita utility would likely involve exploiting natural resources beyond the rate at which they are able to regenerate. This could lead to fewer resources—and consequently, lower standards of living and poorer health—in the future. Therefore, to determine what population would maximize long-term per-capita utility, it is once again necessary to consider the carrying capacity of the Earth, which we have previously estimated to be between 4 and 8 billion. Furthermore, it is important to recognize that the long-term per-capita utility will likely be below the carrying capacity for the same reasons noted in our discussion of the Repugnant Conclusion. If we take the quantity of resources as fixed, spreading those resources among a smaller population would mean more for everyone, leading to improvements in quality of life.

However, it is also important to note that the quantity of resources is not fixed. Even in our discussion of short-term per-capita utility, it was observed that a population that is too small might lack sufficient diversity of skills, leading to economic inefficiencies and reduced access to specialized services. And the quantity of resources is likely to be even more variable in the long run. In our discussion of long-term total utility, it was established that improvements in technology have historically empowered humanity to keep producing more with less, increasing the number of people our planet can support. Given that larger populations are generally correlated with higher levels of innovation, it is possible that a larger population would be better able to harness the power of technological growth, offsetting the strain on resources that it creates.[23] Therefore, while our current population may be far above the long-term per-capita utility maximizing level given our present technologies, it remains possible that a higher population could foster innovations that improve per-capita utility in the long-term.

Conclusion

As the analysis in this paper demonstrates, determining the optimal global population is a complicated and at least partially subjective process. Even accepting utility maximization as the ultimate goal—common practice within the field of economics—there remains considerable variability depending on whether that utility is measured as an aggregate or per-capita, and in the short or long term. From the standpoint of short-term total utility maximization, it seems likely that the optimal global population is far higher than its current level, potentially in the vicinity of 20 billion. However, from the standpoint of short-term per-capita utility, the optimal population is likely lower than our current level, perhaps by a significant margin. The same is true from the standpoint of long-term utility, both total and per-capita, although that has the potential to change if technological advancements continue to expand the productive capacities of the planet. It is also worth noting that technology is not the only largely exogenous factor influencing the

[23] Kremer, Michael. "Population Growth and Technological Change: One Million B.C. to 1990." The Quarterly Journal of Economics. Vol. 108, No. 3 (Aug., 1993), pp. 681-716. https://doi.org/10.2307/2118405

optimal population. For example, raising livestock for human consumption is extremely inefficient from an energy perspective.[24] As a result, by shifting to a plant-based diet, it would be possible to support a larger population with a lower carbon footprint.[25] Consequently, it is important to remember that the optimal population is by no means a fixed number but rather one ever-shifting in response to changes in how we live. Finally, even if we accept that the earth is above (or below) its optimal population, that does not mean that policymakers should aggressively seek to bring it to its optimal level. Indeed, the dangers of doing so are underscored by China's One Child Policy. Though intended to prevent overpopulation, it ended up creating demographic imbalances that have left China with a rapidly aging population that younger generations may be unable to support.[26] Therefore, attempts to bring populations to levels perceived as optimal should be approached with caution and moderation.

Acknowledgments

I would like to thank my advisor for the valuable insight provided to me on this topic.

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[25] Ibid.
[26] Walsh, Bryan. "How China came to regret its one-child policy." *Vox*. Jan 18, 2023. https://www.vox.com/future-perfect/23558772/china-population-overpopulation-one-child-policy-demographics-aging-beijing-xi-jinping

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