Proceedings of the 8th International Conference on Economic Management and Green Development
DOI: 10.54254/2754-1169/129/2024.18365

What is the Optimal Global Population?

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Abstract: The question of what constitutes the optimal global population has long been a topic of debate among scholars. Historically, different perspectives, from Plato's ideal city-state size to modern utilitarian approaches, have sought to define this optimum. While economic theories like average and classical utilitarianism suggest that the optimal population maximizes either individual or societal utility, real-world complexities make it challenging to pinpoint a precise number. Factors such as technological progress, resource consumption, and regional disparities further complicate the determination of an optimal population. This paper explores these challenges, emphasizing that the notion of an optimal population is fluid and highly context-dependent. It argues for a more nuanced approach that considers the interplay of diverse factors, rather than attempting to define a single, static figure.

Keywords: Optimal Population, Utilitarianism, Demographic Challenges.

1. Introduction

Population plays critical roles in the economy, society, and national defense. Thus, the question of what constitutes the optimal global population has intrigued some of the greatest minds since antiquity. Plato first claimed that an ideal number of citizens for a city-state would be 5040, and in modern economics, the utilitarianist school has paid particular attention to the question, contributing two major theories: average utilitarianism and classical utilitarianism. While average utilitarianism aims to maximize the average utility per individual, classical utilitarianism seeks to maximize the total utility of society[1]. Both theories identify the optimal population size as the point where the utility, either of each individual or of the society, stops increasing.

In reality, however, determining an optimal population faces many challenges.

Economists address the genesis problem and elect to answer it with equations [2], but they often tend to neglect other prominent issues. Theoretical models assume the existence of a central authority with complete information on the utility of the society to make population decisions. However, in the real world, it is the households that individually make decisions about childbearing, and these decisions are influenced by household income, educational and healthcare resources, cultural and religious norms, and many other constraints.

2. Methodology

Consequently, any attempt to provide a single precise number as the optimal global population would be trivial and arbitrary, as the number may fluctuate dramatically under different external conditions. Instead, a more meaningful approach would be enumerating the factors that influence the optimal population, and discussing how their interactions alter the outcome. The complexity in outcomes is primarily attributed to the fact that the optimal population question spans a multifaceted array of disciplines, with people from all backgrounds and professional fields providing different perceptions of what constitutes "optimal" . Further, demographics around the globe are far from uniform. While some countries or regions are overpopulated, others may be underpopulated. The article is therefore planned accordingly, with the first section discussing how perceptions of optimal population may vary in different fields, and the second section delving into regional disparities and how various countries address the "demographic problem" differently.

To begin, the mystery of optimal global population is shrouded with disagreement over the definition of optimum. While most economists borrow the term of utility and focus on achieving a decent level of average material wealth to guarantee optimal life quality, recent scholars have introduced the idea of sustainability, emphasizing the need for a population size allowing for "human living on Earth at any one time" [3]. The 1994 paper by Daily et al. identified six pillars that constitute the optimum, including proper nutrition, basic human rights, and preservation of cultural diversity. Yet, the authors focused on energy consumption and environmental protection throughout the body of their paper, leaving little attention to the other pillars.

Even though economists struggle to define the optimum, it is generally agreed upon that the optimal population is far lower than the planet's maximum capacity, provided that a mass population would lead to low resources per capita and poor life quality. The environmentalist approach tends to pull this view to an extreme, arguing that even the present population consumes excessive fossil fuels and non-renewable energy, posing the risk of the depletion of Earth's resources and ecological degradation. Thus, they contend that the optimal population size would be even smaller than the present number. For example, Daily's 1994 paper concluded that the desired population size should be 1.5 to 2 billion, a number much smaller than the actual world population of 5.5 billion when the paper was written.

The calculation of the environmentalist approach, however, is based on the strong assumption of technological stagnation: the gross quantity of resources and the efficiency with which humans utilize these resources remains stable. Without technological advancements, the global population would have to undergo either resource austerity or depopulation upon exceeding a certain threshold. The population is therefore stabilized around an equilibrium for long periods of time; such dynamics is known as the Malthusian population trap.

3. Results

These dynamics, however, fail to explain the exponential population growth observed since the industrial revolutions. This trend is demonstrated by the Solow growth model, which explains sustained development and population growth by incorporating technological innovations into its analysis of outputs. It is possible that in the future, technological advancements could increase the optimal global population by yielding higher work output with the same amount of resource input, or by the usage of new resources.

This approach is also confronted with another challenge. The environmentalist approach implies that population reduction could reduce greenhouse gas (GHG) emissions and help mitigate global warming. However, Greaves's paper in 2017 highlights that climate change is driven by cumulative GHG emissions over time, rather than individual emission rates. Therefore, population reduction would not resolve climate change, and only postpone the arrival of hotter temperatures. That said, focusing excessively on the optimal population may not be a favorable strategy to address climate change. Instead, the global population must take measures to eliminate the GHGs already emitted into the atmosphere, which necessitates sufficient technological research and development.

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Contrary to environmentalists, development economists commonly define the optimal population as the population size that enables an economy to achieve its highest growth rate or maximum product per capita [4]. For development economists, regulating the fertility rate is more important than deciding a number for static optimal population size. It is widely believed that in countries at earlier stages of demographic transition, a decline infertility creates chances for economic growth [5]. Specifically, having fewer children allows households to allocate more resources to each child's education and healthcare, and allows women to actively participate in the workforce. The CIA Factbook states that all 15 countries with the highest birth rates are located in Sub-Saharan Africa[6]. The study by Karra et al., using data from Nigeria, has anticipated that decreasing the fertility rate from high to low variant may yield a twofold increase in income per capita over a period of 90 years.

4. Discussion

By observing the channels that facilitate this economic increase, the authors have recognized the importance of adapting low-skilled labor forces to high-end sectors. As such, a lower fertility rate does not automatically lead to economic prosperity; it should be accompanied by proper policies that encourage more people to pursue tertiary education and work in skilled labor forces. However, as the economy develops and fertility rates remain low, the persistence of economic efficiency is also doubtful. Empirical evidence shows that, while the effect is significant as labor forces are absorbed in modern sectors, it tends to diminish as the economic structure approaches maturity[7]. From this point onwards, economic development is likely to deviate from the anticipated path and fall to low-speed growth, stagnation, or even recession in the event of a labor shortage. The government would then need to shift its family planning policies to maintain optimal productivity.

Another factor that hampers the calculation of the optimal global population is the vast disparities across regions and countries. The 2015 paper by Lianos and Pseiridis constructed an ideal world where all countries share the same level of energy consumption, and the optimal population for each country depends solely on the country's endowment of arable land. The result was astonishing; apart from a few exceptions such as the US and Russia, most countries would be severely overpopulated, with China and India both having an excess population of nearly one billion. This estimation, however, was highly distorted as it failed to account for uneven energy consumption patterns across different countries. While around 20% of the world's population from wealthy countries account for 70% of daily world energy consumption, the other 80% rely on only 30% of daily energy consumption [8]. Growing economies, such as China and India, have a lower per capita energy consumption and thus could support a larger population than predicted by models. On the other hand, advanced economies, such as the US, which enjoy larger per capita energy consumption and are responsible for severe energy waste, have a population much closer to its optimal level.

Hence, economists find themselves trapped in a dilemma when calculating the optimal world population. If all countries were to adopt the lifestyle of high-income economies, a sharp decrease in population would be inevitable to remain within global energy constraints. On the other hand, when economists pursue Pareto optimization to minimize all potential disparities, wealthy countries would still have to compromise on their energy consumption level to avoid drastic depopulation.

Countries also display demographic disparities in terms of fertility rate and age structure. While economists warned of a "population bomb" in African countries, causing massive

starvation due to excessively rapid population growth [9], Europe and East Asia face the opposite issue: a declining fertility rate and an aging population. For example, the populations of South Korea and Uganda are similar in size (51 million vs 48 million),but their age structures are completely different; the median age in South Korea is 43, and in Uganda, 16.[10]

Therefore, if these disparities are not considered when determining the optimal population for these two countries, the results will be trivial and unrealistic, regardless of the models or formulae

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applied. Uganda, together with several Sub-Saharan African countries, possesses one of the youngest populations in the world. While a family planning initiative is necessary, the government should also expedite the development of modern industries to ensure that the job market can accommodate its working-age population. On the contrary, despite already grappling with overcrowded cities and excessively high estate prices, South Korea is still in urgent need of policies to boost its fertility rate to mitigate the risks of economic stagnation and the collapse of the pension system.

It's also worth noting that various theories for the optimal population have emphasized the maintenance of cultural diversity, suggesting that each culture requires a certain population size to sustain its languages, traditions, and social practices. While the global population can be assumed static in short-term scenarios, the population of a specific country or a local community can experience much more significant fluctuations. Movements across countries, regions, or cities face little restrictions. At the same time, developed economies and big cities often exert siphon effects on the working-age population of surrounding areas as they provide education, healthcare resources, and career opportunities. Hence, even regions with high fertility rates, which would not typically face population concerns, can still confront the threat of a shrinking population, as their population may migrate to areas with a stronger cultural presence or actively assimilate into more dominant cultures. These dynamics further complicate the calculation of a finite number for the optimal global population.

5. Conclusion

To conclude, determining the optimal global population is fraught with challenges due to the coexistence of numerous definitions of "optimum" and the need for further refinement in the methodologies used by both environmentalists and development economists. In addition, cross-regional disparities in energy consumption, age structure, and cultural presence have further obscured the calculations. One thing is certain: even though the world population has surpassed previous figures proposed by economists and theorists, starvation is vanishing and the absolute poverty rate is falling in almost every region in the world. Infrastructures and new technologies have collectively raised the upper bound for population capacity[11]. Demographic issues persist, but not quite in the manner predicted by the overpopulation hypotheses. Thus, the optimal global population would be the point at which mankind stops all its development and progress, perhaps.

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DOI: 10.54254/2754-1169/129/2024.18365

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