Proceedings of the 4th International Conference on Business and Policy Studies
DOI: 10.54254/2754-1169/163/2025.20682

# *Optimal Global Population: Balancing Development, Environment and Well-being in Dynamic Equilibrium*

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***Abstract:*** This paper examines the complex and multifaceted relationship between population growth, economic development, resource allocation, and social welfare, focusing on the evolving concept of the "optimal global population." It highlights how moderate population growth can boost economic productivity and living standards by fostering technological innovation and driving industrial transformation. Conversely, unchecked growth intensifies issues such as resource depletion, environmental degradation, and social inequality, creating significant barriers to sustainable development. Recognizing the diversity of global contexts, the analysis emphasizes the need for region-specific and adaptive policymaking. It advocates for aligning demographic trends with economic strategies, environmental sustainability, and social policies to promote balanced and harmonious global development. Additionally, it underscores the importance of global collaboration to tackle shared challenges, such as ensuring equitable resource distribution, fostering innovation, and protecting the environment for future generations. Ultimately, the paper concludes that the "optimal global population" is not a fixed figure but a dynamic and evolving concept. Achieving this balance demands continuous monitoring, informed decision-making, and a steadfast commitment to sustainable development, social equity, and environmental stewardship.

***Keywords:*** Optimal population, population growth, economic development, sustainable development, resource allocation

## 1. Introduction

The intricate relationship between population growth, economic prosperity, environmental resources, and social welfare has been a focal point of global discourse, reflecting its critical importance in shaping the future of humanity. Population growth exerts a profound influence on economic systems, resource allocation, and social stability, creating opportunities for advancement while posing significant challenges to sustainability. David and Richard [1] observed that moderate population growth can stimulate economic expansion, fostering higher productivity and improved living standards. Such growth drives technological innovation, promotes industrial restructuring, and strengthens global competitiveness. However, as Huang et al. [2] noted, uncontrolled population growth leads to the depletion of natural resources, environmental degradation, and exacerbates social inequalities, ultimately impeding sustainable economic development. Adding to the complexity is the uneven distribution of population across the globe. Overpopulated regions, such as East Asia, face intensified pressures on natural resources, heightened environmental stress, and an increase in social

DOI: 10.54254/2754-1169/163/2025.20682

conflicts due to overcrowding. In contrast, underpopulated areas like Australia grapple with labor shortages, slower economic progress, and challenges in maintaining infrastructure and services. These regional disparities not only hinder local quality of life but also disrupt global economic equilibrium, creating a dual challenge of addressing localized issues while maintaining global sustainability.

In today's interconnected world, population dynamics have transformed into a global issue that transcends the borders of individual nations. Modern economies are deeply interdependent, amplifying the ripple effects of demographic changes. Willey [3] argued that the optimal population should be defined by prioritizing quality of life and political freedoms, ensuring that individuals can lead fulfilling lives within the constraints of their environment. Hulett [4], on the other hand, advocated for a more pragmatic approach, calculating maximum population limits based on agricultural and industrial carrying capacities. Together, these perspectives underline the importance of striking a balance between human needs and environmental sustainability, which remains a central challenge for policymakers worldwide.

Beyond these theoretical frameworks, new perspectives emphasize the role of technological advancements and global collaboration in addressing population-related challenges. Advances in renewable energy, precision agriculture, and sustainable urban planning have the potential to mitigate the negative impacts of population growth while enhancing resource efficiency. Moreover, the rise of digital technology enables better population data collection and analysis, supporting data-driven policymaking to optimize resource allocation and economic planning. This paper delves into the dynamic interplay between population growth, economic development, resource distribution, and social welfare, providing a comprehensive analysis of their interconnected impacts. It argues that the concept of the "optimal global population" is not a static figure but a fluid and evolving target that must adapt to changing global conditions. By examining historical theories, contemporary challenges, and emerging solutions, the analysis highlights the need for region-specific strategies and international cooperation. Ultimately, achieving sustainable development requires an unwavering commitment to balancing population dynamics with economic growth, environmental stewardship, and social equity, ensuring a prosperous and harmonious future for all.

## 2. Determinants of Optimal Population

### 2.1. The relationship between population growth and economic growth

Malthus theorised in 1798, the means of sustenance grow linearly whilst population boosts exponentially. The disparity in the rate of growth leads to overpopulation and consequent suffering due to inadequate resources to support a growing population [5]. Furthermore, as the population continues to increase, the depletion of resources and the persistence of poverty forms an inevitable circle. This is because of the increasing demand for resources, which lowers salaries and living conditions for disadvantaged individuals. This can be corresponded to the theory of resource scarcity [6], which reveals that a rapid population growth does not necessarily accompany economic growth due to scarce resources [7]. This is exemplified by the social security system: The growing elderly population causes financial burden on the government's pension and healthcare systems, leading to tonight 's deficit. By 2023, the percentage of individuals aged 65+ in Japan has risen to 29.1%. According to the National Institute of Social Security and Population Studies, Japan spent 25.2% of the GDP on subsidising healthcare, pensions and childcare in 2021. The accelerated ageing poses severe problems to these social fields and the overall economy [8][9]. Furthermore, ageing is shrinking the availability of workforce, inducing a direct obstacle to economic prosperity [10][11]. Government policies such as increasing the retirement age and training women labour and the elderly

DOI: 10.54254/2754-1169/163/2025.20682

may offer short-term relief for labour shortages. However, these measures also have drawbacks, including higher opportunity costs and potential negative impacts on the employment.

prospects and career advancement of younger individuals [12][13].

Oppositely, the neoclassical endogenous growth theory points out population as the main engine for technological advancements and capital accumulation [14]. It claims that population not only provides a greater pool of human resources, but also drives technological developments, hence enhancing labour productivity and contributing to economic growth [14]. Furthermore, population increase is closely linked to economic restructuring. This is because an abundance of young workers tends to propel labor-intensive industries and invigorate the economy. The economy, therefore, may shift towards being more services-oriented, which alleviates the detrimental effects caused by changes in the age structure [15][16]. Over the past 20 years, developed countries like the United States, the United Kingdom, and Germany have experienced growth in their high-tech industries, especially the service sector, which has contributed to their overall growth [17]. Population growth results in increased competition in the job market, which in turn encourages workers to enhance their abilities to adapt to the dynamic changes in industry and skill requirements [18].

Of those population models, endogenous growth theory aligns more closely with the current global trend. This is because advancements in science, technology, and the methods of resource allocation have significantly changed. On the comparison, Malthus's idea was proposed prematurely, failing to include the swift advancements in technology, which renders it somewhat pessimistic. While neoclassical endogenous growth theory demonstrates that population growth plays a crucial role in driving structural transformation and economic growth. It achieves this by fostering technological advancements, increasing capital accumulation, facilitating dynamic adjustments in the labour market, and highlighting the fundamental influence of population on shaping the modern economy.

## 2.2. The relationship between population growth and resources and environment

Sustainable development emphasises the realisation of stable economic growth and social progress under the premise of preserving the ecological environment and maintaining natural resources for the next generation. As an essential component of sustainable development, green economic growth seeks to achieve mutual progress of economy and environment by enhancing resource utilisation efficiency, strengthening scientific and technical innovation, and optimising industrial structure [19].

With a continuing increase of population, land resources are facing substantial threat. According to the World Food Programme, by 2024, almost 309 million people will not be able to meet their daily dietary needs [20], compromising food security [21]. Meanwhile, as another large element of natural resources, marine resources should also be paid attention to. According to the Environmental Marketing Laboratory, ocean food will account for 12-25% of the population's demand for meat by 2050 [22]. However, with the rapid development of population in coastal cities, the marine environment is threatened. Due to overfishing, over-utilization of water resources and marine pollution, the equilibrium of the ocean ecosystem has been disrupted, affecting the survival of marine species [23]. As per Pacoureau [24], overfishing has resulted in the eradication of more than 70% of certain shark populations within the past 50 years. Thus, societal attention should be directed into assessing the correlation between global food production and population increase, as well as exploring the potential of marine food sources to satisfy the needs of the expanding population. This is crucial in order to guarantee a sufficient and consistent food supply while also safeguarding the health and stability of marine ecosystems [25].

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### 2.3. The relationship between population growth and social welfare

Increased competition in the labour market enables companies to hike wages, which in turn reduces worker's disposable income and impacts their overall well-being. The assessment of a country's overall development is typically done using the Human Development Index (HDI),which considers factors such as health conditions, education, and income level. The geometric increase in population can impact all of the aforementioned factors [26]. Population expansion in education has resulted in an increase in the need for educational resources, wherein there is a pressing demand for teachers, instructional resources, and educational materials. In addition, population increase exacerbates the strain on medical resources in the field of medicine. As elderly people grow, the incidence of chronic diseases and geriatric disorders also increases, demanding more advanced medical services. The population growth has directly resulted in a significant increase of essential living resources, including food, clothes, housing, and transportation.

Hence, the balanced population policy and social policy are inherently connected. Social policies and programmes, such as education, health, and employment policies, should be compatible with anticipated demographic trends. These policies aim to enhance the quality of life while ensuring a population size that is conducive to social and economic development [27].

## 3. Whether we have reached an optimal population?

Based on the factors that need to be considered in the above analysis, a discussion is carried out in the developed and developing countries that account for the majority of the world's population regarding whether we have reached the optimal population.

### 3.1. Developed countries

Developed nations have substantial invested in innovation and education, rising living standards and promoting sustainable economic growth. Nevertheless, as a result of advancements in education and the rise in employment opportunities, the fertility rate has experienced a general fall [28]. Moreover, the life expectancy continues to increase, exacerbating the extent of aging in the population and pressuring pension and healthcare expenditure. The necessity to address the sufficiency and durability of pensions, as well as optimise the distribution of medical resources, has emerged as pressing concerns in developed nations. In order to establish a virtuous cycle of economic growth, social progress, and environmental protection, it is necessary to develop reasonable population policies that take all relevant aspects into consideration [29].

### 3.2. Developing countries

Developing countries are generally faced with the problem of rapid population growth due to the high birth rate driven by traditional fertility concepts and social factors, and the relatively low life expectancy caused by medical conditions, nutrition levels and hygiene habits, which has brought huge economic pressure [30]. However, with the rapid population growth, the demand for resources in developing countries continues to increase, and economic activities increase, resulting in increasingly prominent environmental pollution problems [31]. Besides, these countries generally face the problem of low per capita GDP and low labour productivity due to low levels of education and technology, and it is difficult to effectively promote economic and social development. As a result, when considering the optimal population for a developing country, it is important to include problems such as the high birth rate and relatively low life expectancy, concerns about the economic pressure brought about by population growth, as well as the increasing demand for

DOI: 10.54254/2754-1169/163/2025.20682

resources and the aggravation of environmental pollution problems. Additionally, considering the level of education and technology of developing countries, we should seek the best way to promote the coordinated development of population and economy and society.

## 4. Discussion: Dynamic Link between the Factors

The four factors—population, economy, environmental resources, and social welfare—are deeply interdependent and continuously interact with each other, as highlighted by Repetto [32]. The relationship among these elements is complex and characterized by a dynamic balance that evolves over time. Typically, the growth of the global population is accompanied by an expansion and intensification of economic activities. This economic growth drives higher demand for resources, resulting in more consumption and putting additional pressure on the environment. As industries expand to meet the needs of a growing population, they often lead to greater resource extraction, energy use, and emissions, which exacerbate environmental issues like climate change and biodiversity loss. Policy-making should not only address the immediate economic and population growth needs but also prioritize the sustainable use of resources and the protection of the environment. As Wang et al. [33] point out, a balanced approach to development requires careful consideration of both the short-term and long-term impacts of economic growth on the planet's finite resources. However, the rapid pace of population growth, economic fluctuations, and uncertainty surrounding resource availability create significant obstacles. These fluctuations can lead to instability in resource supply, affecting everything from food security to energy access. At the same time, environmental problems are often aggravated by overconsumption and unsustainable practices, further complicating the task of achieving balance. This complex relationship makes it exceedingly difficult to pinpoint a fixed "optimal population" figure, as demographic, economic, and environmental factors are continually shifting. The evolving nature of these variables requires societies to remain adaptable and vigilant, continuously monitoring and assessing the effectiveness of policies. Policies must also be flexible as populations grow, evolving to accommodate unforeseen changes in economic conditions, technological advancements, and environmental circumstances.

Moreover, the way that this dynamic balance is understood and operationalized may vary considerably across different countries and regions. Juknys et al. [34] emphasize that the approaches to managing these interactions are often shaped by local contexts, including economic status, technological capacity, and societal priorities. Developed nations, with more advanced technologies and higher levels of industrial efficiency, tend to focus on reducing resource consumption and environmental pollution through innovation and increased efficiency. These countries leverage technological progress in energy production, waste management, and sustainable agriculture to mitigate their ecological footprints. For example, many industrialized nations invest heavily in renewable energy sources and energy-efficient technologies to decouple economic growth from environmental degradation.

On the other hand, low- and middle-income countries often face a different set of priorities and challenges. These nations are primarily concerned with boosting economic growth and alleviating poverty, which frequently leads to increased resource consumption and a higher environmental impact. Aliyeva [35] notes that in such countries, economic development often takes precedence over environmental sustainability. As these nations industrialize and urbanize, their resource demands grow, and the environmental consequences can be severe. In these regions, the focus is often on expanding infrastructure, improving living standards, and creating jobs, which may inadvertently lead to higher carbon emissions, deforestation, and waste generation. While efforts to address these issues are underway, the immediate need for economic growth can sometimes overshadow the long-term goals of sustainable resource management and environmental conservation.

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## 5. Conclusion

This paper asserts that "Global optimal population" is not a fixed number, but a complex and changeable concept, which needs to be dynamically adjusted on the basis of balancing human development needs, resource conservation and environmental sustainability, taking into account factors such as population, economy, environmental resources and social welfare. In a world made up of many different perspectives from many different sides, achieving harmonious development is a complex and interrelated issue. Therefore, achieving a dynamic balance requires recognizing these differing perspectives and adapting strategies accordingly. It is essential to consider regional variations in priorities and capacities when crafting policies aimed at achieving sustainability. A one-size-fits-all approach is unlikely to succeed, and policies must be tailored to the specific needs and circumstances of each country or region. The global community must foster greater collaboration and share knowledge to ensure that both developed and developing nations can move towards a more sustainable future, balancing the growth of population, economy, and resource use with the protection of the environment.

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