Charting the Course for Sustainable Aging: Socio-Environmental and Economic Impacts on Djiboutian Elderly Population

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Abstract
The aging population has become a crucial demographic trend worldwide, as it poses both economic and sustainable challenges to governments and societies. And, ostensibly, this unprecedented increase in the senior demographic is currently unfolding in East African nations, primarily, due to substantial advancements in the healthcare system and the commendable support and promotion of education within the region. In this context, the current article examines the relationship between the aging population, ecological footprint, consumption of renewable energy, governmental healthcare expenditures, trade, and urbanization within the context of the Republic of Djibouti. To investigate the data and explore the dynamics and interactions among variables, a comprehensive approach was employed, which involved utilizing an autoregressive distributed lag (ARDL) model, a Granger causality test, and both an impulse response function (IRF) and variance decomposition (VD) analyses. According to the ARDL findings, urbanization has a positive relationship with an aging population. In contrast, the health sector expenditures demonstrated a negative association with the elderly population in Djibouti. This indicates an alarming scenario where government spending on elderly care fails to effectively meet the specific needs of seniors due to insufficient funding, bureaucratic inefficiencies, and inadequate program implementation. Consequently, this leads to a significant gap in coverage for a large portion of the elderly population. On the other hand, it is worth noting that the well-being of the elderly population in Djibouti sees only a slight improvement influenced by the trade performance variable. Nonetheless, this positive impact is somewhat hindered by the lack of sufficient financial inclusion measures that should have ideally been driven by trade-related activities. Moreover, the study's IRF and VR highlight a positive shock between the consumption of renewable energy and the well-being of the elderly population. Nevertheless, it is of utmost importance to recognize the detrimental impact of the ecological footprint, which significantly undermines the overall well-being of the aging population. Therefore, policymakers must carefully weigh and benefit the simultaneous effect of the advantages of renewable energy consumption on the environment, and on the well-being of the elderly population. It is also essential to emphasize the need to devise more inclusive policies that can comprehensively address this issue and improve the welfare of the elderly demographic.

Keywords
Sustainable aging; ecological footprint; fiscal policies; urbanization; trade; Djibouti, ARDL model.

Introduction
The world population will age more rapidly as a consequence of lower fertility and rising lifespan. It is estimated, that by 2100, 38% of the world’s population might be above the age of 65. Aging populations in OECD (Organization for Economic Cooperation and Development) nations, for example, face a chronic and complicated issue with substantial social and economic repercussions. And, surprisingly, such as demographic transformation is already unfolding across the majority of OECD countries (Desa, 2019). The African states also have their fair share of demographic transition. East Africa, for example, has always had a youthful population. Various factors such as advancements in healthcare, the evolution of educational opportunities, and declining fertility rates have

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contributed to an unprecedented shift towards a more balanced age distribution in society. Notably, the enhanced healthcare services have resulted in decreased mortality rates, enabling a greater number of individuals to reach old age. Similarly, in recent years, the Republic of Djibouti has made substantial investments in the education and healthcare sectors, largely driven by the government’s progressive policies and its visionary 2050 agenda (La nation, 2020; Nation, 2021). This comprehensive vision includes the provision of affordable national healthcare and unrestricted access to free education. Consequently, these initiatives have heightened awareness of healthcare practices, leading to the adoption of healthier lifestyles and ultimately contributing to improved longevity. The decrease in fertility rates can also be attributed to the aging population as most young adult population and freshly graduate showcasing apathy toward marriage. For instance, in a report published by the UN on the world population prospect; the percentage of East Africans aging 60 and older rose from 4.7% in 1950 to 7.1% in 2020, and is projected to grow to 8.4% by 2025 (UN, 2019).

Generally, Djibouti is classified as a lower middle-income country by the World Bank (World Bank, 2022), and with this in mind, the country's leadership has persistently advocated for economic agendas to bolster its economic performance since gaining independence in 1977. One notable strategy employed to stimulate economic growth has been the strategic exploitation of Djibouti's advantageous geographic position, particularly its location on the Bab-el-Mandeb strait. This approach has yielded job creation opportunities. However, the utilization of ports as a means of driving economic growth has concurrently exacerbated national-level disparities, particularly in terms of financial inequalities.

From a cultural and social perspective, Djibouti represents a multicultural and linguistically diverse nation. Although the official languages are French (inherited from its former colonizer) and Arabic (reflecting its religious affiliation and membership in the Arab League), the country comprises three major ethnic groups: Afar, Arabs, and Somalis. Each ethnic group possesses its own distinct culture, traditions, and language, contributing to the rich tapestry of Djibouti's cultural heritage. At the environmental level, Djibouti faces a range of challenges and opportunities. Situated in a geographically unique location at the intersection of the Red Sea and the Gulf of Aden, Djibouti boasts a diverse ecosystem with rich biodiversity. However, the country is also vulnerable to environmental risks such as desertification, water scarcity, and climate change impacts. Djibouti has been actively engaging in environmental conservation efforts, including the establishment of protected areas and initiatives to promote sustainable land and water management. Additionally, Djibouti's commitment to renewable energy development. In a joint effort between the Ministry of Environment and the Ministry of Higher Education, a collaborative initiative was undertaken in 2022, resulting in the formal establishment and inauguration of the Regional Research Observatory for the Environment and Climate “RROEC” (ORREC, 2022). Geothermal and solar power highlights its efforts towards sustainable energy endorsement. Nonetheless, there is a continued need for effective environmental policies, resource management, and international cooperation to address the environmental challenges faced by Djibouti and ensure the preservation of its unique natural heritage for future generations.

Within this framework, it is ostensible that scholars have addressed the ramifications of senior demographic economic, environment, and societal scopes. Goh and McNown's (2020) study reveals a compelling relationship between the growth of the elderly population and its impact on key macroeconomic indicators. Specifically, an increase in the elderly population by one standard deviation corresponds to a projected decline of three percentage points in the fiscal account balance relative to GDP. The study further demonstrates that the future trajectories of crucial macroeconomic variables, including saving, investment, real GDP, fiscal balance, and current account balance, align with the temporal patterns of demographic drivers. Interestingly, this analysis suggests that the pace of population aging is not uniform, leading to more favorable medium-term prospects for the macroeconomy than anticipated based solely on measures of
population aging. These positive prospects include reductions in the fiscal deficit as a proportion of GDP, higher saving and investment ratios, and a shift towards current account surpluses.

Razin et al. (2002), and Denton and Spencer (2019) delved into the intricate ramifications of population aging, exploring its impact on various aspects such as social welfare, healthcare services, labor force growth, the productive capacity of the economy, consumer demand levels, investment rates, sectoral allocation of investments, and the demand for public services. Interestingly, their studies yielded divergent outcomes that stood in stark contrast to the initial expectations. Their remarks, generally speaking, conveyed a rather bleak sentiment instead of instilling confidence, as they highlighted the disquieting reality of rising expenses tied to age-related programs such as pensions and healthcare—since, generally, an increase in expenditures is directly proportional to the prevailing trend of population aging. In other words, When the population gets older, there is usually more money spent. Significantly, elderly individuals tend to exhibit an escalating inclination towards healthcare consumption and medical interventions, driven by the natural course of physiological decline and waning resistance that accompanies the aging process. Yet, despite the challenges posed by population aging, many countries are showing remarkable adaptability in response to this demographic shift.

On the other hand, Guimaraes and Tiryaki’s (2020) research findings provide valuable insights into this phenomenon, revealing that nations with aging populations tend to experience lower levels of consumption and investment volatility. However, there is an observed increase in output volatility as the population continues to age. This can be attributed to the dynamic interplay between labor market responses to aging and the heightened volatility in international trade. Nevertheless, the intricate ramifications of senior demographic influences are characterized by a protracted and enduring process, wherein the full extent of their effects often requires an extensive temporal horizon to fully materialize. The observable outcomes resulting from the initial perturbation in fertility rates can be likened to merely the visible pinnacle of a vast and multifaceted phenomenon. With this, we believe, substantial implications are anticipated to unfold as the economy gradually adjusts and acclimatizes to the continuously evolving dimensions and age composition of the population in the forthcoming decades. Scholars, also juxtaposed the environment and aging population, while a segment of the literature argues that the growing elderly demographic could potentially yield detrimental consequences for the environment (Agyekum & Kumar, 2021; Lu et al., 2021), another perspective emerges, highlighting, a positive scenario wherein an increase in the senior population could actually facilitate the transition towards a more sustainable, environmentally friendly society (Yang, 2021; Mehmood, 2022).

Therefore, the article aims to examine the relationship between the aging population factor, environmental variables, macroeconomic factors, and one social variable to provide cardinal policy implications for Diboutian authorities to effectively address the senior demographic from several points. The paper contributes to the literature from several perspectives. First, we examine population aging from three veins, macroeconomic, environmental, and societal. In other words, we integrate population aging with an ecological footprint, renewable energy consumption, trade, urbanization, and government expenditures for health into a unified model. Furthermore, in the realm of scholarly inquiry about the aging population, preceding research endeavors have predominantly employed a fragmentary approach, scrutinizing isolated facets of this phenomenon. Conversely, the present study diverges from this conventional paradigm by adopting a holistic perspective that encompasses a confluence of interrelated factors. Specifically, the focal point of this research lies in the concerted examination and accentuation of the interplay between sustainability, economic dimensions, and societal elements within the context of aging. Moreover, a significant void in prior scholarly discourse emerges from the notable omission of a comprehensive assessment of the intricate interrelationship between aging and its associated ecological footprint. Rather,
the predominant focus of previous research has been disproportionately oriented toward the examination of carbon dioxide emissions and renewable energy consumption as singular indicators of sustainability, thus neglecting the broader spectrum of ecological implications entwined with the aging phenomenon (Estiri & Zagheni, 2019; Yang, 2021; Mehmood et al., 2022). Furthermore, government allocation to the health sector factor will provide a unique threshold to assess how a healthier fiscal allocation might be related to the aging population’s well-being. Likewise, in a parallel vein, the examination of trade dynamics assumes a pivotal role alongside health expenditures within the purview of this study’s macroeconomic implications, acknowledging their significant influence and impact on the elderly population. Trade factors can provide us with a new evaluation of demographic transformation, as the selected country is located in a desirable trade location. According to the Djibouti Ports and Free Zones Authority (DPFZA) (Explore Xinhua, 2022), the Port of Djibouti handled a total of 5.7 million tons of cargo in 2020, which is a 3% increase compared to 2019. Whereas, in terms of container traffic, the Port of Djibouti handled approximately 1.4 million TEUs (Twenty-foot Equivalent Units) in 2019.

It also is noteworthy to highlight that the present study is based on the Republic of Djibouti, which represents the first scholarly research conducted in this country. This study is unique compared to previous research, as it primarily focuses on an African country classified as a lower-middle-income nation, whereas past studies have often emphasized upper-middle-income countries (World Bank, 2022).

To further enhance the degree of originality within this study, effectively address the data, and conduct a concise evaluation of the relationship between the selected variables, the current article employs a comprehensive array of sophisticated statistical techniques. Notably, the Autoregressive Distributed Lag (ARDL) model, Granger causality test, variance decomposition, and Impulse Response Function are meticulously utilized as instruments, thereby facilitating a robust and quintessential analysis of the research subject matter. The article is structured as follows. A review of the literature is presented in Section 2, after the introductory section. Methodology and data are introduced in Section 3. Empirical findings and broad observations are presented in Section 4. The discussion can be found in Section 5, and conclusion and policy recommendations are provided in Section 6.

Review of previous works

The fiscal implication of the senior population

The developmental strategy employed in the past, by aging nations, has contributed to the state’s active engagement in maintaining a nation's finances as well as in some nations’ innovation process, such as those of the OECD countries. Broadly speaking, the indispensable prerequisite for achieving this proactive performance lies in the State’s multifaceted functions as the foremost economic overseer and communicator, along with its pivotal role as a catalyst for technological progress and a driver for financial advancement (Souza & Boente, 2023).

Many empirical and theoretical works have explored the macroeconomic effects of population composition (Nakahigashi & Yoshino, 2016; Hu & Zhao, 2021; Doerr & Ongena, 2022). One key area receiving a lot of scholarly interest has been the fiscal effect of aging populations. Three categories can be used to broadly classify previous studies. First, let’s examine the potential impact of population aging on national finances. According to the research of Hondroyiannis and Papapetrou (2000), Greece’s population structure from 1960 to 1995 was characterized by low rates of births and a large proportion of old people who were dependent on the state. Due to this demographic tendency, there has been a “double aging” trend—in which the aging process of the population has been accompanied by an increase in government debt and fiscal
spending. The country’s budgetary development, therefore, suffered as a result of this. The second scenario emphasizes forecasting the future impact of population aging on governmental finances. This involves major tax changes, social security rises, and welfare cuts, which are all linked to the long-term budgetary impact of population aging (Auerbach & Kotlikoff, 1985; Bielecki, Brzoza-Brzezina, & Kolasa, 2018; Ferrero et al., 2019). To properly deal with the entire effects of population aging, some have suggested that public finance has to be projected beforehand and that proactive actions need to be taken to reorganize fiscal revenue and spending and decrease the debt load (Hu & Zhao, 2021; Doerr & Ongena, 2022).

It is also worth mentioning, the scope of fiscal implication, in the context that the health of the aged population has significant financial ramifications—since it is obvious that sicknesses and poor health among seniors require public funding to provide health care services. The prevailing literature suggests that fiscal implications manifest as the paramount factor within this macroeconomic threshold. In light of this, it is judicious to draw upon the insightful work of Bixby (2020), who presents a conscientious exposition of budget trends, portraying a disconcerting panorama. Bixby asserts that the current outlook is even more disquieting than it was two decades ago, highlighting the exponential growth in unchecked expenditures, particularly in the realm of social programs, coupled with tax cuts that were implemented in the aftermath of the Great Recession. These factors contribute to the deepening national deficit, engendering an unsustainable predicament. Bixby issues a warning, emphasizing the imperative need for enhanced fiscal responsibility and meaningful interventions to address the precariousness of the debt. Such interventions encompass endeavors to enhance the value of healthcare, ensure the solvency of Social Security, and bolster the level of the workforce. Failure to undertake these measures portends a decline in living standards for younger generations, posing a direct threat to the fundamental essence of the nation. It should come as no surprise that Bixby reminds us of the long-anticipated "Age Wave" looming on the budgetary horizon, a phenomenon that we have been aware of for decades, yet have failed to adequately prepare for its imminent arrival. Although in 2016-2017 the Japanese government proposed a plan involving fiscal stimulus to compensate for the economic drawback and provide financial security for the elderly population, alas, due to this substantial fiscal transformation, the Japanese infrastructure drastically diminished—in terms of quality and the proportion of amount required to be allocated to infrastructure sectors, similarly, a huge increase of social welfare cost materialized due to the aging population demand, thus, resulted in a budget deficit, which further impeded the government's expansion plan for spending mission (Nakahigashi & Yoshino, 2016).

Yoshino and Miyamoto (2017) investigated how the elderly demographic impacts GDP performance as well as the efficacy of fiscal and monetary policy. The author created a New Keynesian dynamic model including workers and retirees in heterogeneous households. According to their findings, raising the share of the workforce enhances aggregate production, consumption, and spending in the long term by boosting the total workforce. Additionally, it increases incomes and reduces the nation's social welfare cost. Their article also indicates that as the share of retirees increases, so does the efficiency of fiscal and monetary policies. In a similar vein, the connection between population aging (or life span) and healthcare provision has been researched in academia. Jaba et al. (2014) used a panel model to get data for 175 nations and identified a substantial link between health spending and life span for the years 1995 to 2010. Murthy and Okunade (2016) recognized that real yearly earnings, the percentage of the population that are 65 years or older, and the standard of healthcare equipment as the main determinants of health spending per capita by using annual data from 1960 to 2012 and the ARDL (autoregressive distributed lag cointegration) approach. Linden and Ray (2017), contended that there is a correlation between public health spending, particularly private spending, and living standards for 34 OECD nations between 1970 and 2012.
Yet, a second mainstream of literature argues for the so-called negative effect of the elderly population in infusing a greater burden on the state (Maity & Sinha, 2021; Nagarajan et al., 2016). According to their reasoning; population aging boosts years of education and enhances investment chances for human capital. People start to focus more on improving their own labor productivity rather than seeking the expansion of the household workforce, at the same time, when the older population increases life expectancy and people's propensity for raising children decreases (Ladd & Murray, 2001). Similarly, in pursuit of enhanced future labor remuneration, individuals augment their spending on educational pursuits, specialized training, and specific industries, to elevate the skill sets of both themselves and their household members. Consequently, this concerted effort not only contributes to the individual's prospects of obtaining higher economic compensation but also serves as a catalyst for technological advancement (Gradstein, & Kaganovich, 2004). Likewise, through two additional channels, population aging can also support the modernization of the industry structure and technical advancement (Siliverstovs et al., 2011). The first is the impact of learning by doing. More formally—the average working age rises along with the knowledge and competence levels of the workforce, which boosts the effectiveness of innovative work. The second is that the workforce shortage brought on by population aging forces an adjustment in the economic cycle of growth and a focus on technology advancements, which in turn prompts the diffusion of socioeconomic capital and encourages skill transmission and innovation to boost economic merit.

D'Antonio (2020) presents also a perspective that leans towards a more optimistic outlook for the intersection of politics and aging in the times to come. While mainstream society tends to dismiss aging as an inconsequential subject unworthy of substantial contemplation or purposeful policy discourse, D'Antonio acknowledges the potential for each individual, as a member of an aging world, to actively shape our collective destiny. D'Antonio's optimistic scholarly contribution aligns with a perspective that endorses fostering a societal paradigm. This societal transformation holds the promise of a future characterized by a harmonious blend of political and fiscal equilibrium, along with a greater emphasis on intergenerational justice and the genuine embodiment of democratic ideals.

**The interplay between aging populations and economic factors**

Interestingly, Groezen et al. (2005) encapsulated the ad-hoc effect of an aging population on economic performance, regardless of the overturned threshold (negative or positive), for instance, the author made the case that the transmission mechanism—the accumulated wisdom of the older population determines the direction of the influence of aging on economic growth. This highlights the idea that experience increases productivity since older people have accumulated a wealth of information. Nevertheless, this beneficial impact ends after a certain age threshold—since they are no longer able to contribute to the output level. Yet, as people age, they tend to save more, which leads to more capital accumulation, and ultimately, increases growth. Furthermore, they demonstrate that over time, declining mortality and fertility rates both positively and adversely explain economic development. The aging's beneficial impact on growth relies on how fertility rates stack up against mortality fluctuations.

The relationship between macroeconomic factors and the aging population is indeed controversial and projects discrepant findings in the literature. Research conducted by Mitra and Guseva (2021) argues that population aging has both short and long-term implications on net FDI inflows (as a percentage of GDP) for 22 OECD nations between 1980 and 2017. The findings indicated that the short-run consequences are negligible. In the long run, governments' efforts to mitigate the negative consequences of population aging have a considerably favorable impact on net FDI inflows (as a percentage of GDP). The author disproved the idea that the older population would result in a considerable decline in net FDI inflows. When the number of individuals of working age declines, domestic labor becomes scarcer, thus, increasing the need for foreign capital. The
following finding has been supported by Tomohara (2017), Abedin (2020), and Mitra and Abedin (2021a), who contend that inward Foreign direct-encouraging programs might address domestic manpower and resources deficiencies. For example, spending on health and education would boost net FDI inflows (% of GDP), which would lessen the consequences of a shrinking population.

However, this is at variance with Aksoy et al. (2019) work, who conducted an extensive analysis utilizing data from twenty-one developed countries spanning the period between 1970 and 2007. Their research shed light on the intricate relationship between dependency ratios, specifically old-age dependency ratios, and key economic dimensions. The study revealed a compelling pattern wherein higher dependency ratios and old-age dependency ratios were linked to notable reductions in various crucial aspects of economic activity. These encompassed a decline in the number of hours worked, diminished levels of savings, a contraction in capital formation, and a decrease in innovation as manifested by a decline in patent applications. Roberts and Mehlman (2018) also suggest the aging of the world population will likely lead to slower economic development, lower interest rates, changes in consumption, and changes in housing patterns. This will have major effects on investment since economies that have high rates of capital investment have often seen rapid economic expansion. Likewise, by employing state-level data for the years 1980, 1990, 2000, and 2010 within the United States, Maestas et al. (2016) undertook a comprehensive examination to discern the relationship dynamics between demographic composition and economic performance. Their investigation unveiled a noteworthy finding, namely that a 10 percent increase in the ratio of the population aged sixty years or older to the population aged twenty or over exhibited a consequential impact on the rate of growth of gross domestic product (GDP) per person. Specifically, this demographic shift was associated with a 5.5 percent reduction in the rate of growth of GDP per person. Notably, two-thirds of this decline was attributable to a reduction in the growth of labor productivity distributed across various age groups, while the remaining one-third resulted from a decline in the growth of the labor supply, thus indicating the presence of an extensive margin effect. These findings highlight the intricate interplay between population aging, labor dynamics, and economic growth, contributing to our understanding of the multifaceted factors influencing macroeconomic performance. Authors such as Papapetrou and Tsalaporta (2020), and Liu and McKibbin (2022) also caution about the potential negative implications of the aging population if appropriate policies are not formulated.

Although, from a less depressing angle, Metu et al. (2020) employed a GMM and OLS model to demonstrate the interaction impact of domestic investment and an aging population on economic development using a sample of 28 African nations from 1995 to 2017. The outcome indicates that the effect of aging on the economy is strongly negative, indicating that the expanding number of seniors has a decreasing effect on production. Yet, when aging and investment collide, the coefficient becomes positive and substantial, suggesting that increasing domestic investment might help lessen the negative impact of the elderly on economic development. Their study concludes that the government's aging population creates significant obstacles to African economic progress. African nations may enhance their economies by using domestic investment to lessen the negative effects of an aging labor force.

In a similar context, in an extensive study encompassing 169 countries over the period 1990 to 2015, Acemoglu and Restrepo (2017) conducted a meticulous analysis aiming to discern the intricate interplay between population aging and economic performance. Surprisingly, their findings revealed an absence of correlation between changes in population aging (quantified as the ratio between the population aged fifty or over and the population within the age range of twenty to forty-nine) and changes in the gross domestic product (GDP) per person. In fact, most econometric specifications employed by the authors yielded a positive statistical relationship, a trend that persisted even when extending the analysis to the period from 1965. These outcomes prompted the authors to propose a potential explanation: countries with older populations are
adopting industrial robots at an accelerated pace compared to their counterparts with younger demographics. This adoption of automation technologies could be attributed to a reduction in the number of younger workers available in the labor force.

In their comprehensive investigation, Wongboonsin and Phiromswad (2017) delved into a relationship linking national demographic structure (encompassing more than just population aging), to economic growth. The authors employed a statistical technique rarely utilized in economics, namely the two-stage causal search PC algorithm, the authors analyzed data from 122 countries ranging over the period from 1960 to 2010. Their study focused on five key demographic indicators, representing the shares of different age groups within the population: individuals aged under fifteen years, between fifteen and twenty-four, between twenty-five and forty-four, between forty-five and sixty-four, and sixty-five years or over. They evaluated both direct and indirect causal relationships between these demographic indicators and the levels of economic activity and economic growth. The outcomes of their analysis yielded distinct findings based on the developmental status of countries. In developed countries, an increase in the share of the population aged between forty-five and sixty-four was associated with a positive impact on economic growth. Conversely, an increase in the share of the population aged sixty-five or over was found to have a detrimental effect on economic growth. On the other hand, for developing countries, population aging was not identified as a significant factor associated with economic growth. In fact, the evidence suggested a negative association between a higher proportion of the population under fifteen years of age and economic growth.

**Toward a sustainable aging society**

The relationship between aging and environmental variables has also been studied in the literature. According to Dalton et al. (2008), older individuals use less private transportation, which lowers the usage of vehicles and other resources and hence lowers pollution. Hassan and Salim (2015) also state that, over the long term, a 1% rise in the proportion of the elderly population leads to a 1.55% reduction in per capita CO2 emissions. In a similar context, Lu et al. (2021) looked at how the age dependence ratio affected the use of green and non-green energy in BRIC countries. According to the panel’s findings, the appetite for renewable and nonrenewable energy by older people is positively associated with market growth and dependence. The aging population and air pollution have been linked in another research by Dalton (2008); the author contends that the elderly consume fewer resources and prefer mass transportation, making them relatively more ecologically friendly in comparison to the younger generation. O’Neill et al. (2010), and Agyekum and Kumar (2021) likewise, support the so-called “favorable theory of aging and sustainability”, as older individuals limit economic growth and emit scant amounts of carbon dioxide, and do not engage in labor-intensive activities.

A similar strategy has been emphasized by Mehmood et al. (2022), who found that the G-11 nations’ CO2 emissions will decrease by 13.41% for every 1% rise in their aging population. Similar to this, carbon footprint has been addressed in the majority of studies on how older people and the environment interact. Prior research by Dalton et al. (2008) on the effects of aging populations on carbon emissions in the United States demonstrated that seniors can reduce long-term CO2 emissions by about 40% at small populations levels. They draw attention to the fact, that, in certain circumstances, the effect of aging on environmental deterioration is just as big as or even greater than the influence of technological advancement. Research on the link between age dependence, environmental sustainability, and the economy found that an older population reduces family spending and increases national savings, resulting in both immediate and supplementary effects on economic growth (Zhang, 2023). Another study that aims to combine the effect of an aging population on environmental quality found that the studied nations’ (OECD) lengthy CO2 emissions are reduced altogether as a result of population aging and increased overall country quality (Fatima et al., 2020; Yang et al., 2021; Wang & Liu, 2021; Aden, 2022; Pais-Magalhães et al., 2022).
However, according to Farzin and Bond (2006), cultures with a high percentage of age dependency have higher carbon pollution. Yet, this contradicts most findings about culture and environment, for instance, the role of culture in fostering sustainable behavior is a substantial one, as evidenced by the potential of Pro-Environmental Behavior (PEB) to mitigate environmental pollution and promote the sustainable development of society. Cross-cultural studies have revealed significant variations in PEB across countries with diverse cultural backgrounds, and even within the same country or region, individual cultural values exhibit notable distinctions. This leads to an intriguing question: Do different individual cultural values exert varying influences on PEB? To shed light on this inquiry, the paper by Mi et al. (2020) delves into the mechanisms through which cultural value differences impact residents’ PEB, drawing upon Hofstede’s cultural model as the theoretical framework. Through an analysis of 475 questionnaires completed by residents, the study uncovers noteworthy findings. It establishes that Hofstede’s five dimensions of cultural value have a substantial impact on public- and/or private-sphere PEB. Notably, collectivism and long-term orientation among residents demonstrate positive effects on both public- and private-sphere PEB, while uncertainty avoidance exerts a negative influence. Moreover, the research identifies three significant social-demographic characteristics, namely gender, age, and educational level, that serve as moderating factors in the relationship between cultural values and PEB.

For instance, in recent years, there has been a notable emergence of various concepts and frameworks that establish explicit connections between culture and sustainable development. Notably, Jon Hawkes’ commissioned book, "The Fourth Pillar of Sustainability: Culture’s Essential Role in Public Planning" (Hawkes, 2001), which was informed in part by UNESCO’s earlier discourse, provided an ideological foundation for UNESCO’s agenda. The book emphasized the significance of cultural and artistic expression as one of the four pillars of sustainable development, alongside environmental responsibility, economic well-being, and social equity. It recognized the intrinsic value of culture, including a vibrant cultural life, within a broad and intangible framework. This particular pillar is often referred to as "cultural-aesthetic" or "religious-spiritual", highlighting the diverse dimensions and perspectives encompassed within the cultural sphere. This approach primarily adopts a culture-centric perspective and advocates for the maintenance and preservation of the cultural field, rather than prioritizing the transformative path proposed by the Sustainable Development Goals (SDG). Instead, it serves as a call to redirect more attention toward cultural considerations in the realm of public planning. The notion of culture being recognized as the "fourth pillar of sustainable development" has gained substantial support, evident through its deliberation during the UNESCO Expert Meeting titled "Towards a New Cultural Policy Framework" in 2009. Its influence has also permeated among urban stakeholders, such as the United Cities and Local Governments, thereby underscoring the growing acknowledgment of the significance of culture in driving sustainable development initiatives within cities and communities (Wiktor-Mach, 2020).

Ostensibly, incorporating culture as a societal context relatively worths the intention, especially within the sustainability path. It is indeed myopic to consider that sustainability could be achieved without completely turning to societal frameworks and creating a path with demographic transformation and growth. Economist David Throsby analyzed the role of culture in sustainable development as part of a research paper commissioned by UNESCO in 2008. Throsby (2001) focused on measures aimed at ensuring the preservation and vitality of “cultural capital,” which encompasses elements of local cultures, cultural diversity, and available resources. He introduced the concept of "culturally sustainable development," which emphasizes the importance of passing cultural heritage to future generations. Throsby argued that culture should be regarded as a fundamental component within a comprehensive understanding of sustainable development, alongside environmental and socio-economic aspects. Consequently, he advocated for culture to be prioritized rather than treated as a secondary concern in
global development agendas. From a pragmatic standpoint, Throsby proposed the recognition of the economic value of cultural industries as a crucial step towards fully integrating culture into the development discourse while taking into consideration demographic transformation (Throsby, 2001).

Keeping in line with the literature, Menz and Welsch (2010a), revealed that older citizens use more commodities that need a lot of energy, which increases carbon emissions. In a different study, Menz and Welsch (2012b) show that a nation's developmental phase affects the relationship between CO2 emission and an aging population. The impact of the elderly is also linked to age-specific energy demand in both the consumption and manufacturing sectors. In this regard, it is proved that older individuals are likely to be against tougher environmental regulations (Heijdra et al., 2006). Additionally, regarding the relationship between age dependency and environmental inclinations, Thalmann (2004) found that as people get older, their propensity to pay for better ecological quality, or "green taxes" declines. The study's findings imply that although older individuals would immediately pay the expenses, however, they would not eventually take advantage of better environmental quality or environmental regulations, which would progressively minimize the level of environmental awareness. Strictly speaking, the aging population could differ in terms of portraying greener attitudes depending on their income status or provincial development locations.

In a similar vein, carbon emissions and demographic aging were shown to be positively associated across the nation, according to Zhang and Tan (2016), the fact that carbon pollution rises with population age is further confirmed, however, the effects varied by country due to their degrees of development. According to Estiri and Zagheni (2019), there are several ways in which the older population influences carbon emissions. The first has to do with considering one's age when engaging in economic activity. The second is that the demands of various generations vary, particularly in terms of energy usage, which has an impact on the industrial system. The third is that as lifespans increase, they make greater preparations for the environment and their own futures. According to the impact paradigm, demographic change has an influence on urbanization and industry structure, which in turn has an impact on carbon emissions.

Methodology

Data sources and variables

The study uses yearly time series data with a range of years from 2000 to 2021 with Djibouti as a target nation. In general, the aging population in Africa is expected to increase significantly in the coming years due to several factors, such as increased life expectancy, improved healthcare, and decreased fertility rates. Djibouti, a small country located in the Horn of Africa, is also experiencing a demographic shift toward an aging population. Therefore, it is important to investigate the aging population in Djibouti and its implications for the country's social, economic, and health sectors. Additionally, the aging population in Djibouti is also likely to have significant economic implications for the country. The elderly population may require increased healthcare services, social services, and financial support. These demands may place an additional burden on the country's already strained resources, which could lead to reduced economic growth and increased poverty rates. Additionally, the retirement of the elderly population may result in a loss of valuable skills and knowledge, which could negatively impact the country's productivity and competitiveness. The current article stands out by incorporating a combination of macroeconomic factors and environmental variables, making it the first study to address senior demographics in this context.

With this in mind, the current study considered the "percentage of the population aged 65 and above" as a measurement of the aging rate. Because it reflects the proportion of
the population that is entering old age and may require additional resources and services to maintain their health and well-being. This measurement is also known as the old-age dependency ratio. It assists the specific country in knowing the changes in the age structure of a population and can inform policy and resource allocation decisions related to healthcare, pensions, and social services (Tang & Li, 2021). Further, various indicators are selected namely, urbanization, trade, and government expenditure on health (Coccia, 2021). The following variables provide both cardinal macroeconomic and societal scope. Whereas, the consumption of renewable energy and ecological footprints play crucial roles in determining the level of environmental sustainability within a country. For instance, an increase in the percentage of the population utilizing renewable energy sources signifies a strong commitment to climate change initiatives. On the other hand, a rise in ecological footprints indicates a deficit in biocapacity, meaning the available area for sustaining the population diminishes. Such a scenario poses a direct threat to the overall well-being of the Djiboutian population, including the elderly demographic. It is worth mentioning that the ecological footprint metric holds particular value in sustainability evaluations due to its comprehensive implications compared to other environmental and sustainability variables. (Nathaniel, Anyanwu, & Shah, 2020; Ahmed et al., 2022).

To proceed with the study, the paper performed Autoregressive distributed lag (ARDL). The model is useful for determining both the long-run and short-run connections between variables. It is particularly useful when dealing with small sample sizes and mixed-order variables, as it allows for the estimation of both short-term and long-term effects of changes in variables. It may also be used to determine if two variables have a cointegrating connection, which denotes that they have a state of balance over time. Although to proceed with an ARDL approach the data should fulfill several criteria. It is important to note that the ARDL approach deals with problems of autocorrelation and endogeneity and provides unbiased and super-consistent coefficients with valid t-statistics (Pesaran et al., 2001).

Although to proceed with an ARDL approach the data should fulfill several criteria. First, we choose the variables to be included in the model and specify the appropriate order of integration for each variable using unit root tests such as Augmented Dickey-Fuller or Phillips-Perron tests. Second, we select appropriate values for maximum lags using one or more information criteria during model formulation and include cross-equation restrictions within the long-run parameters if necessary. Third, we conduct a diagnostic test to assess the model’s goodness of fit and the presence of any residual autocorrelation, heteroscedasticity, or serial correlation. After fulfilling the above criteria, then we generally estimate the ARDL model using two stages: first, estimating the short-run dynamics by regressing the dependent variable on its lags and contemporaneous values of the explanatory variables, and second, estimating the long-run dynamics with an error correction term that captures the speed at which the system returns to equilibrium after experiencing a shock. Additionally, we examine the Granger causality between the variables to determine the direction of causality. Following by a variance decomposition (VD) and impulse response (IRF) to analyze the dynamic response of the variables to shocks or changes in the system and to understand the proportion of forecast error variance attributed to each variable in the model. Nevertheless, some authors stop only at the causality stage, however, many researchers include the IRF and VD. Finally, we proceed by Interpreting the results of the model and drawing conclusions about the relationship between the variables, including both short-run and long-run effects, Table 1 provides information on the variables and their source.

<table>
<thead>
<tr>
<th>Table 1. Variables' description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variable</strong></td>
</tr>
<tr>
<td>Dependent</td>
</tr>
<tr>
<td>Independent</td>
</tr>
</tbody>
</table>
Model specification

For an empirical analysis of cointegration, we use the ARDL technique. One advantage of the ARDL technique is that it does not demand the same level of integration for each variable. It does not really matter whether a factor has a variable order of integration, order zero integration, or order one integration. This feature makes ARDL superior to conventional cointegration techniques. Because the test's capacity to detect cointegration is diminished when there is a mixed order of integration, standard cointegration procedures become unstable. Our model's general functional form is as follows:

\[ P = \beta_0 + \beta_1 RN_t + \beta_2 UP_t + \beta_3 GVH_t + \beta_4 T_t + \beta_5 E_t + \epsilon_t \]  

(1)

We observe that P is the aging population, and RN, UP, GVH, T, and E are the renewable energy consumption, urbanization health expenditure, trade, and ecological footprints. Once Equation (1) is log-linearized, the below equation is generated:

\[ P_t = \beta_0 + \beta_1 RN_{t-1} + \beta_2 UP_{t-1} + \beta_3 GVH_{t-1} + \beta_4 T_{t-1} + \beta_5 E_{t-1} + \epsilon_t \]  

(2)

In this equation, \( \beta_0 \) is the constant, and \( \epsilon_t \) is regarded as the equation's error term. The parameters of \( \beta_1 \) through \( \beta_5 \) are the coefficients that are utilized to calculate the aging population. Additionally, it is possible to compute both the short-run and long-run coefficients simultaneously. The preceding model was developed to establish ARDL bounds:

\[ \Delta P_t = \alpha_0 + \sum_{i=1}^{p} \alpha_1 \Delta P_{t-i} + \sum_{i=1}^{p} \alpha_2 \Delta RN_{t-i} + \sum_{i=1}^{p} \alpha_3 \Delta UP_{t-i} + \sum_{i=1}^{p} \alpha_4 \Delta GVH_{t-i} \]

\[ + \sum_{i=1}^{p} \alpha_5 \Delta T_{t-i} + \sum_{i=1}^{p} \alpha_6 \Delta E_{t-i} + \lambda_1 P_{t-1} + \lambda_2 RN_{t-1} + \lambda_3 UP_{t-1} \]
\[ + \lambda_4 GVH_{t-1} + \lambda_5 T_{t-1} + \lambda_6 E_{t-1} + \epsilon \]  

(3)

The \( \alpha \) parameters in the equation denote the short-term relationship. On the other hand, the \( \lambda \) symbol represents long-term relationships. Consequently, this approach tests the null hypothesis of no cointegration (\( \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = \lambda_6 = 0 \)) or the alternative hypothesis of cointegration (\( \lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq \lambda_5 \neq \lambda_6 \neq 0 \)) based on the F-test. The importance of the bottom and higher limit numbers, which were principally articulated by (Pesaran et al., 2001), also had a role in the development of this F-test. This technique, therefore helps in giving useful details on whether the pieces are perfectly correlated. So, if the parameters are serially correlated over a lengthy period of time, an error correction model is employed to calculate each variable's coefficient. The equation is displayed below:

\[ \Delta P_t = \gamma_0 + \sum_{i=1}^{p} \delta_i \Delta P_{t-i} + \sum_{i=1}^{p} \phi_i \Delta RN_{t-i} + \sum_{i=1}^{p} \phi_i \Delta UP_{t-i} + \sum_{i=1}^{p} \phi_i \Delta GVH_{t-i} \]
\[ + \sum_{i=1}^{p} \phi_i \Delta T_{t-i} + \sum_{i=1}^{p} \phi_i \Delta E_{t-i} + \mu ECT_{t-1} + v_t \]  

(4)

In this model, the parameters \( \mu \), reflect the speed of adjustment, and ECT stands for the error correction term.
Granger causality

The purpose was to show the factors' causal linkages. To ascertain if there is a meaningful relationship between the indicators, the Granger causality test proposed by Granger (1969) was carried out. The strategy is explained in further context below:

\[ X_t = \sum_{t=1}^{p} (a_{11}X_{t-1} + a_{12}Y_{t-1}) + \mu_t \]  
\[ Y_t = \sum_{t=1}^{p} (a_{21}X_{t-1} + a_{22}Y_{t-1}) + \epsilon_t \]

As illustrated in equations 5 and 6, p implies the order of the model, \( a_{ij} \) (i,j = 1, 2) denotes the coefficients expressed in the model, while \( \mu_t \) and \( \epsilon_t \) denotes the residuals. A causation linkage between X and Y may be established using F tests, and the parameters can be computed using simple least squares.

Empirical findings

The statistical information guided the regulators' trend analysis throughout the course of the time span and allowed them to conduct a thorough investigation of the factors that impacted the reliant variables. The factors' statistical characteristics are shown in Table 2. The percentage of the aging population ranges from 4.49% to 3.20%, with an average of 3.80%. With a kurtosis of 1.61% and a standard deviation of 0.44%, the distribution is positively skewed. In Djibouti, renewable energy consumption and the ecological footprint have an average value of 30.92%, and 6.17% with an upper limit of 34.05, and 6.45 percent. Additionally, the findings reveal a negatively skewed distribution for all the variables except for the aging population, and ecological footprint. The greater standard deviation value in RN demonstrates the wide variability of renewable energy consumption in Djibouti. The correlating matrix is yet another key technique for obtaining inferences between elements before they are examined. In Table 2 the results indicate a negative correlation of -0.741 and -0.381 between renewable energy consumption, and government expenditure in health with the aging population. On the other hand, urbanization, trade, and ecological footprints presented a strong positive correlation with the aging population of Djibouti.

Table 2. Overall statistics

<table>
<thead>
<tr>
<th></th>
<th>P</th>
<th>RN</th>
<th>UP</th>
<th>GVH</th>
<th>T</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>3.800020</td>
<td>30.92955</td>
<td>5.851961</td>
<td>1.505661</td>
<td>2.430053</td>
<td>6.171851</td>
</tr>
<tr>
<td>Maximum</td>
<td>4.495469</td>
<td>34.04000</td>
<td>5.936883</td>
<td>2.143886</td>
<td>2.796574</td>
<td>6.452197</td>
</tr>
<tr>
<td>Minimum</td>
<td>2.05250</td>
<td>24.13000</td>
<td>5.754267</td>
<td>0.965054</td>
<td>1.903090</td>
<td>5.92785</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>0.442770</td>
<td>3.011253</td>
<td>0.055306</td>
<td>0.349688</td>
<td>0.350165</td>
<td>0.170748</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.165928</td>
<td>-0.902813</td>
<td>0.055306</td>
<td>0.349688</td>
<td>0.350165</td>
<td>0.170748</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>1.610165</td>
<td>3.011253</td>
<td>0.055306</td>
<td>0.349688</td>
<td>0.350165</td>
<td>0.170748</td>
</tr>
</tbody>
</table>

Source: Authors' estimations based on e-view
The outcomes of the DF-GLS, PP, KPSS, and ADF tests are displayed in Table 3. After initial divergence, any variables that are not stationary at level turned stationary at I (1). This suggests that all of the factors under consideration are either I (0) or I (1), not I (2), and that none of them are I (2). It is noteworthy to mention unlike other tests the KPSS test revealed a mix of stationarity at both the level and first difference.

Table 3. Unit Root tests

<table>
<thead>
<tr>
<th>Variables</th>
<th>(ADF)</th>
<th>(PP)</th>
<th>(DF-GLS)</th>
<th>(KPSS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level</td>
<td></td>
<td>First difference</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>-2.535</td>
<td>-1.028</td>
<td>-3.384***</td>
<td>0.650**</td>
</tr>
<tr>
<td>RN</td>
<td>-1.158</td>
<td>-1.194</td>
<td>-1.064</td>
<td>0.417*</td>
</tr>
<tr>
<td>UP</td>
<td>-0.701</td>
<td>-2.941*</td>
<td>-0.483</td>
<td>0.665**</td>
</tr>
<tr>
<td>GVH</td>
<td>-0.665</td>
<td>-0.560</td>
<td>-0.762</td>
<td>0.218</td>
</tr>
<tr>
<td>T</td>
<td>-1.797</td>
<td>-1.665</td>
<td>-1.432</td>
<td>0.400**</td>
</tr>
<tr>
<td>E</td>
<td>-0.733</td>
<td>-0.988</td>
<td>-0.255</td>
<td>0.627**</td>
</tr>
</tbody>
</table>

Note: *, ** and *** denotes 1%, 5%, and 10% level of significance
Source: Authors' estimations based on e-view

The Autoregressive distributed lag test approach will help us evaluate the short- and long-run elastic qualities between components to develop successful policy measures. In light of this, the components demonstrate long-run linkages and are sequentially connected, as indicated by the ARDL boundaries projection in Table 4. The F-statistics are notable at the 1% level with a 6.639 value and fall below the I (1) upper limit after considering causation and partial equilibrium correlations between variables. We shall thus move forward with the error correction and long-run estimate.

Table 4. ARDL Bounds Testing Estimates

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>Value</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-Statistic</td>
<td>6.639151</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Critical Value Bounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Significance</td>
</tr>
<tr>
<td>10%</td>
</tr>
<tr>
<td>5%</td>
</tr>
<tr>
<td>2.5%</td>
</tr>
<tr>
<td>1%</td>
</tr>
</tbody>
</table>

Source: Authors' estimations based on e-view

Table 5 demonstrates that the Adjustment error correction factor is quantitatively meaningful and negative (-0.596). This claim illustrates how quickly equilibrium returns after a shock to the long-run causal connection. According to the short-run and long-run results, most of the variables appear to have a significant association with the aging population. Starting with long-run estimates, we observe that UP causes a positive impact on the aging population of Djibouti. This implies a 1% increase in urbanization generates a 7.80% increase in the well-being of the aging population in Djibouti. This positive connection could be explained by the fact that Urban areas typically have better access to healthcare facilities, including hospitals, clinics, and specialist doctors. This can be especially important for aging populations, who may have more health concerns and require more frequent medical attention.
Next, the government expenditure on health and trade displayed a detrimental influence on the aging population of Djibouti. For instance, we perceive the budget allocated to the healthcare sector and trade are decreasing the well-being of the population by 0.07% and 0.06% respectively. Further, both in the long run and short-run factors such as renewable energy consumption and ecological footprint indicated no prominent influence on the aging population of Djibouti. Finally, in the short-term estimates, the outcomes uncovered that urbanization does not have any significant impact on the aging population. Similarly, the rest of the variables revealed an insignificant impact on the aging population of Djibouti except for trade which demonstrated a negative impact.

Table 5. ARDL short-run and long-run estimation
Dependent variable: Population above the age of 65
Selected Model: ARDL (4, 1, 1, 1, 1, 1)

<table>
<thead>
<tr>
<th>Short-run cointegrating Form</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>P(-1)</td>
<td>2.078600***</td>
<td>0.245613</td>
<td>8.462911</td>
<td>0.0035</td>
</tr>
<tr>
<td>P(-2)</td>
<td>-3.171238***</td>
<td>0.431198</td>
<td>-7.354644</td>
<td>0.0052</td>
</tr>
<tr>
<td>P(-3)</td>
<td>3.013952***</td>
<td>0.480824</td>
<td>6.268303</td>
<td>0.0082</td>
</tr>
<tr>
<td>P(-4)</td>
<td>-1.518012**</td>
<td>0.285082</td>
<td>-5.324827</td>
<td>0.0129</td>
</tr>
<tr>
<td>RN</td>
<td>0.000415</td>
<td>0.000823</td>
<td>0.504314</td>
<td>0.6487</td>
</tr>
<tr>
<td>RN(-1)</td>
<td>0.002281</td>
<td>0.001251</td>
<td>1.823824</td>
<td>0.1657</td>
</tr>
<tr>
<td>JP</td>
<td>-2.080752</td>
<td>3.032864</td>
<td>-0.686068</td>
<td>0.5419</td>
</tr>
<tr>
<td>JP(-1)</td>
<td>6.740281</td>
<td>3.238291</td>
<td>2.081432</td>
<td>0.1288</td>
</tr>
<tr>
<td>GVH</td>
<td>-0.023484</td>
<td>0.010778</td>
<td>-2.178928</td>
<td>0.1175</td>
</tr>
<tr>
<td>GVH(-1)</td>
<td>-0.019811</td>
<td>0.013051</td>
<td>-1.517972</td>
<td>0.2263</td>
</tr>
<tr>
<td>T</td>
<td>-0.018777</td>
<td>0.010520</td>
<td>-1.784904</td>
<td>0.1723</td>
</tr>
<tr>
<td>T(-1)</td>
<td>-0.022800*</td>
<td>0.008549</td>
<td>-2.666821</td>
<td>0.0759</td>
</tr>
<tr>
<td>E</td>
<td>0.032972</td>
<td>0.037917</td>
<td>0.869589</td>
<td>0.3968</td>
</tr>
<tr>
<td>E(-1)</td>
<td>0.032385</td>
<td>0.032845</td>
<td>0.986000</td>
<td>0.3968</td>
</tr>
<tr>
<td>C</td>
<td>-25.35206**</td>
<td>7.400288</td>
<td>-3.425821</td>
<td>0.0417</td>
</tr>
<tr>
<td>CointEq(-1)*</td>
<td>-0.596699***</td>
<td>0.050535</td>
<td>-11.80772</td>
<td>0.0013</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Long-run coefficients</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>RN</td>
<td>0.004519</td>
<td>0.002214</td>
<td>2.041538</td>
<td>0.1338</td>
</tr>
<tr>
<td>JP</td>
<td>7.808849***</td>
<td>0.246661</td>
<td>31.65819</td>
<td>0.0001</td>
</tr>
<tr>
<td>GVH</td>
<td>-0.072557**</td>
<td>0.016223</td>
<td>-4.472360</td>
<td>0.0208</td>
</tr>
<tr>
<td>T</td>
<td>-0.069677**</td>
<td>0.019497</td>
<td>-3.573790</td>
<td>0.0375</td>
</tr>
<tr>
<td>E</td>
<td>0.109532</td>
<td>0.092575</td>
<td>1.183177</td>
<td>0.3220</td>
</tr>
<tr>
<td>C</td>
<td>-42.48722***</td>
<td>0.982776</td>
<td>-43.23184</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

Note: *, ** and *** denotes 1%, 5%, and 10% level of significance
Source: Authors' estimations based on e-view

To determine the causation between the variables and whether it exists, one can use the F-statistic, which assesses the Pairwise Granger causality. Table 6 summarizes the Causality association between the indicators as well as the orientation of connection, such as one-way or two-way causality. Generally, the results of the test demonstrate a bidirectional relationship between renewable energy consumption and the aging population, urbanization, and the aging population, and government expenditure on health and the aging population. This implies a causality running from both sides for the aforementioned and the aging population of Djibouti. Finally, we observe a one-way causal association running from the trade to the aging population. Simultaneously, the table exhibits another unidirectional relationship between ecological footprint and the aging population.
The period selected was fixed to 15 years and divided into 5 years to evaluate the impact of each of the factors on the aging population variable. The findings of Table 7 reveal that variations in the elderly population factor are caused by shocks of its own (100.000) as well as impulses from all other variables. Unequivocally, a 15.32 and 58.40% variation in the elderly demographic (0.06%).

Regarding this, urban areas may also provide more opportunities for socialization, with access to senior centers, community events, and other activities. It can be also noted from the table that both trade and health care spending are predicted to impose larger shocks on the aging population variable. For the next 15 years, the ecological footprint factor has a weak impulse impact on the elderly demographic (0.06%).

Table 6. Pairwise Granger causality

<table>
<thead>
<tr>
<th>Variables</th>
<th>F-Statistic</th>
<th>Prob.</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>RN -&gt; P</td>
<td>15.4027***</td>
<td>0.0010</td>
<td>Bidirectional</td>
</tr>
<tr>
<td>P -&gt; RN</td>
<td>4.43913**</td>
<td>0.0494</td>
<td></td>
</tr>
<tr>
<td>UP -&gt; P</td>
<td>25.3831***</td>
<td>0.0000</td>
<td>Bidirectional</td>
</tr>
<tr>
<td>P -&gt; UP</td>
<td>9.80201***</td>
<td>0.0058</td>
<td></td>
</tr>
<tr>
<td>GVH -&gt; P</td>
<td>39.8047***</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>P -&gt; GVH</td>
<td>4.15583*</td>
<td>0.0565</td>
<td></td>
</tr>
<tr>
<td>T -&gt; P</td>
<td>11.6835***</td>
<td>0.0031</td>
<td>Unidirectional</td>
</tr>
<tr>
<td>P -&gt; T</td>
<td>2.2E-05</td>
<td>0.9963</td>
<td></td>
</tr>
<tr>
<td>E -&gt; P</td>
<td>0.75943</td>
<td>0.3950</td>
<td></td>
</tr>
<tr>
<td>P -&gt; E</td>
<td>11.5821***</td>
<td>0.0032</td>
<td></td>
</tr>
</tbody>
</table>

Note: *, ** and *** denotes 1%, 5%, and 10% level of significance

Source: Authors’ estimations based on e-view

Table 7 depicts the variance and decomposition outcome of all the explanatory variables of the model in combination with the aging population variable for the entire time frame. It can be noticed from the table that the time period selected was fixed to 15 years and divided into 5 years to evaluate the impact of each of the factors on the aging population variable. The findings of Table 7 reveal that variations in the elderly population factor are caused by shocks of its own (100.000) as well as impulses from all other variables. Unequivocally, a 15.32 and 58.40% variation in the elderly population for the next 15 years is due to the transformation toward renewable energy consumption, in other words, the introduction to the market of several green initiatives, and an increase in the level of urbanization. The latter (renewable consumption) positively increases the overall welfare and well-being of the senior in the context of living in a green standardized space that supports and accommodates the environment.

Regarding this, urban areas may also provide more opportunities for socialization, with access to senior centers, community events, and other activities. It can be also noted from the table that both trade and health care spending are predicted to impose larger variance shock of 1.092 and 1.16 percent on the elderly demographic (0.06%).

Table 7. Variance decomposition

<table>
<thead>
<tr>
<th>Period</th>
<th>S.E.</th>
<th>P</th>
<th>RN</th>
<th>UP</th>
<th>GVH</th>
<th>T</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.004243</td>
<td>100.0000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>2</td>
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The Impulse Response Function (IRF) displays how a variable responds to a shock (such as a stress of one standard deviation, a stimulus of one unit, etc.) over a specific period of time. A variable’s impact on another factor cannot be determined using the Granger causality or the VD. To ascertain an impact’s route, the IRF evaluation is crucial. The horizontal axis depicts time, while the vertical axis indicates the size of a variable’s responses to a shock—which could lead to either an increase or decrease. The red dotted line substitutes for the confidence bands at 5% significance while the blue line represents the IRF. Figure 1 shows the responses of P, RN, UP, GVH, T, and E to one standard deviation shock of RD. Within this scope, we witness that P’s reaction to the shock varies greatly throughout the course of each time interval. Nevertheless, the shock turned positive and statistically substantial after period 12. Moreover, urbanization, government expenditure on health, renewable energy consumption, and trade react favorably to the shock of the aging population. In the period tenth, these favorable responses are quite consistent. It is also important to highlight that the ecological footprint exhibits a negative shock on the aging population of Djibouti. This could be explained by the fact that Djibouti, a small country with limited natural resources and a fragile ecosystem, an increase in ecological footprint could have negative impacts on the health and well-being of all populations, including the aging population. For example, if the ecological footprint of Djibouti continues to increase, it could lead to increased deforestation, soil degradation, and water scarcity, which could impact the availability and quality of food and water resources. This could negatively affect the health and nutritional status of older adults, who may be more vulnerable to malnutrition and dehydration. Additionally, an increase in ecological footprint could also lead to increased pollution and environmental degradation, which could have negative impacts on the respiratory health and overall well-being of older adults. Exposure to air pollution, for example, has been linked to respiratory diseases such as chronic obstructive pulmonary disease (COPD) and asthma, which can have a significant impact on the health of older adults.

To ensure the integrity and dependability of our chosen model, the study thus makes extensive use of analytic statistical tests, the observations are provided in Table 8. The outcomes indicate that its design is reliable because it passed all diagnostic evaluations. The results of all the diagnostic tests indicate that there are no problems with the model.
For instance, the Ramsey RESET test has demonstrated that the model is not misspecified. The heteroscedasticity of the model is assessed using the Breusch-Pagan-Godfrey test, Harvey, and the ARCH test. The empirical findings show that heteroscedasticity is minor and unimportant. The findings of the Jarque-Bera test also show that the residuals of the model have a normal distribution. Furthermore, the graph resides under the 5% level of significant constraints, which is another indication of the stability of the model according to the CUSUM and CUSUMSQ plots (see Figure 2).

Table 8. The diagnosis tests

<table>
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<th>Test</th>
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<td>Heteroskedasticity Test: ARCH</td>
<td>1.5428/0.2333</td>
<td>No problem of heteroscedasticity</td>
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<tr>
<td>Ramsey RESET Test</td>
<td>0.3961/0.5934</td>
<td>The model is specified correctly</td>
</tr>
<tr>
<td>Jarque–Bera (normality)</td>
<td>0.3166/0.8535</td>
<td>The model is normally distributed</td>
</tr>
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</table>

Source: Authors' estimations based on e-view

Discussion

According to the United Nations, the proportion of people aged 60 and over in Africa was 5% in 2020, and it is projected to increase to 9% by 2050 (Department of Economic and Social Affairs, 2020). In Djibouti, the aging population is also growing, but at a slower pace than in other parts of the world. One factor that contributes to the slower pace of aging in Djibouti is its relatively young population. According to the World Bank, the median age in Djibouti was 25 years in 2020, which is much lower than the global median age of 31 years (World Bank Group, 2020). However, as life expectancy in Djibouti increases and fertility rates decline, the proportion of older adults in the population is likely to continue to rise in the coming decades.

It is worth noting that Djibouti is influenced by a combination of demographic, economic, social, and health-related factors. First, the demographic factors that influence the aging population in Djibouti include changes in birth and death rates, fertility rates, and migration patterns. Djibouti has experienced a decline in infant mortality rates and an increase in life expectancy, which has led to an increase in the proportion of the population aged 60 and over. However, fertility rates remain relatively high in Djibouti, which means that the country has a relatively young population compared to other countries with similar life expectancy rates. Second, economic factors that influence the aging population in Djibouti include changes in employment patterns, income levels, and access to healthcare. Djibouti is a low-income country with a small formal sector, and most people work in the informal sector. This means that many older adults continue to work well into their 60s and 70s, either out of financial necessity or because they have
limited access to social security and retirement benefits. The lack of access to affordable healthcare also means that older adults may have limited access to preventative care and treatment for chronic conditions. Third, social factors that influence the aging population in Djibouti include changes in family structures, social norms, and cultural traditions. Djibouti has a collectivist culture, which means that families are expected to provide care and support for older relatives. However, rapid urbanization and migration patterns have led to changes in family structures, and many older adults may find themselves living alone or without the support of their families. The loss of traditional social support networks can lead to increased social isolation and loneliness among older adults. Third, health-related factors that influence the aging population in Djibouti include changes in disease patterns, access to healthcare, and the prevalence of chronic conditions. Djibouti has a high prevalence of infectious diseases, such as malaria and tuberculosis, which can disproportionately affect older adults. In addition, the country has a high prevalence of chronic conditions such as hypertension and diabetes, which can lead to disability and decreased quality of life in older adults. Limited access to healthcare means that many older adults may not receive timely treatment or preventative care for these conditions.

Therefore, understanding these factors is crucial for developing policies and programs that address the needs of older adults in Djibouti and promote healthy aging while at the same time promoting green policies that are favorable for this demographic trend. Accordingly, the current paper investigated the impact of various social, environmental, and economic indicators on the aging population of Djibouti from 2000 to 2021. To carry on with the research, the paper performed models such as ARDL, granger causality, variance decomposition, and impulse response function. These models enabled us to assess the data from multiple aspects namely, long-run cointegration, causality direction, and the shock of independent variables on the dependent variable.

Based on the empirical findings, the study revealed that an increase in the urbanization rate causes a positive impact on the aging population of Djibouti. This is because urban areas tend to have better healthcare infrastructure and facilities compared to rural areas. This means that older adults in urban areas may have better access to healthcare services, including preventative care and treatment for chronic conditions (Wang et al., 2017). According to He and Jian (2020), Lauf et al. (2016), and Kudo et al. (2015), urban areas tend to be more diverse and offer more opportunities for social interaction and engagement. This can be beneficial for older adults who may be at risk of social isolation and loneliness in rural areas. More importantly, Urban areas tend to have better living conditions compared to rural areas, including access to clean water, sanitation, and housing. This can have a positive impact on the health and well-being of older adults. Although, in the short term, the outcomes uncovered that urbanization does not have any significant impact on the aging population.

Moreover, it is noteworthy that the government’s allocation of funds towards healthcare variables and trade has exhibited an ambivalent impact on the aging demographic in Djibouti. The trade policies implemented by the Djiboutian government have yielded unfavorable repercussions in terms of both affordability and accessibility of essential commodities, including food. Regrettably, these trade policies lack a comprehensive approach aimed at benefiting the entirety of the population, consequently resulting in escalated food prices. Consequently, this detrimental outcome disproportionately affects the health and well-being of older adults, who, due to their heightened vulnerability, are already predisposed to the detrimental consequences of malnutrition. Similarly, it can be observed that the government’s allocation of funds towards the health sector does not consistently accord priority to the requirements of the aging demographic. This is vividly exemplified by the notable disparity in resource allocation, whereby the Djiboutian government directs a substantial proportion of expenditures towards the expansion of the military and education sectors, while comparatively allocating meager resources to bolster the health sector. Thus, leading to a decrease in funding for healthcare and social services that are important for the aging population. Additionally, the level of inequality, in the country is abysmally alarming, for instance—expensive healthcare services are
only available to those who can afford them, and older adults from lower-income backgrounds are unable to access the care they need to maintain their health and well-being. Ostensibly, these blatant disparities can also be linked to the lack of financial inclusion, which not only hinders collective economic benefits but also intensifies the country's inequality.

The result of the Granger causality demonstrated a bidirectional relationship between (1) renewable energy consumption and the aging population; (2) urbanization, and the aging population, and (3) government expenditure on health and the aging population. In line with this finding, Djibouti’s senior demographic can benefit from an increase in renewable energy consumption as it can lead to a decrease in pollution and a cleaner environment. This can help prevent chronic health conditions such as respiratory problems, which are more prevalent in older adults. In turn, a healthier aging population can lead to a decrease in healthcare costs and a decrease in the burden on healthcare systems (Yang et al., 2022). Additionally, renewable energy technologies can provide energy security and access to electricity in remote or underserved areas, which can benefit the aging population (given the fact that Djibouti is still a lower-middle income country and with this in mind, the country’s most major areas are still remote due to lack of infrastructure). For example, renewable energy can power medical equipment and provide lighting and heating in long-term care facilities, which can improve the quality of life for older adults (Su et al., 2022).

Likewise, the aging population can also play a role in promoting renewable energy consumption by advocating for policies and practices that prioritize renewable energy sources. In the urbanization context, cities tend to be better equipped to provide services and facilities that are important for the aging population, such as healthcare services and accessible housing. Urbanization can also provide opportunities for social engagement and activities, which can improve the quality of life of older adults. Similarly, older adults can play a role in shaping the development of cities by advocating for age-friendly policies and practices (Pais-Magalhães, Moutinho & Robaina, 2022). Indeed, older adults can advocate for accessible public transportation and pedestrian-friendly streets, which can improve mobility and reduce social isolation. The aging population can also play a role in promoting sustainable urbanization practices that prioritize environmental sustainability and social equity. Further, government expenditure on health can benefit the aging population by providing access to preventative care, treatment for chronic conditions, and long-term care services (Wang et al., 2022). Subsequently, promoting a healthier aging population, which can lead to a decrease in healthcare costs and a decrease in the burden on healthcare systems. Identically, the aging population can also influence government expenditure on health by advocating for policies and practices that prioritize healthcare services for older adults.

Furthermore, we observed a one-way causal association running from the trade to the aging population. This can be explained by the fact that trade can impact the availability and affordability of healthcare services, medications, and other essential goods for older adults. For example, if trade policies lead to increased prices for prescription drugs, older adults may have difficulty affording necessary medications (Hinek, Stanić & Škarica, 2019; Gu & Stoyanov, 2019). Similarly, the causality test exhibited another unidirectional relationship between ecological footprint and the aging population. This implies that the aging population can have an impact on the environment without the reverse being true.

Furthermore, in accordance with IRF results, urbanization, government expenditure on health, renewable energy consumption, and trade were demonstrated to react favorably to the shock of the aging population. These factors can react favorably to the shock of the aging population by providing access to essential services, promoting healthcare innovation, and supporting sustainable and age-friendly communities. The result also indicated that the ecological footprint exhibits a negative shock on the aging population of Djibouti. The ecological footprint can affect the availability of resources that are
essential for the health and well-being of the aging population (Yang et al., 2021). For example, ecological degradation can reduce access to clean water, nutritious food, and healthcare services. It can also lead to the displacement of populations, which can have significant social and health impacts on the aging population (Zhang, Cui, & Zhang, 2022).

Accordingly, it is important to take into account the myriad cultures that are ultimately flocking into the capital, given the fact that Djibouti is a multicultural country that comprises an amalgam of Arabs, Somalis, and Afars, with each of them possessing their unique cultural values, hence, incorporating cultural contexts into the provision of services and design of living environments for the elderly population should be considered by the Djiboutian governments. To accomplish this, the government should establish an effective cooperative and co-creative framework, engaging key ministries such as the Ministry of Economy, National Heritage & Culture, and Environment. Concurrently, it is significant to recognize the diverse cultural values and practices within the Djiboutian society, so that, national policy-makers can foster an environment that respects and promotes the well-being of older adults. Moreover, promoting cultural preservation can likely contribute to sustainable development, as indigenous knowledge and traditional practices often hold valuable insights for managing natural resources and mitigating environmental challenges, thus, facilitating a secure and conducive environment that nurtures self-expression for the indigenous elderly population would be beneficial. At the same time, it is relatively important to integrate cultural elements into economic strategies, such as tourism and creative industries, as this can foster inclusive growth and provide opportunities for older adults to actively participate in the workforce. The endorsement of the above initiatives would later create age-friendly and culturally sensitive living environments that enhance the quality of life for older adults and encourages social cohesion and intergenerational harmony.

**Conclusion, limitation, and policy recommendation**

In this comprehensive article, a thorough investigation was conducted on the phenomenon of population aging from various dimensions including environmental, economic, and social aspects. The primary focus of the study was on a specific country that has been scantly discussed in the existing literature. This country is categorized as a lower-middle-income nation, characterized by unstable macroeconomic factors that are further exacerbated by internal and external inefficiencies. Furthermore, apart from the economic challenges, the country also faces significant environmental and societal issues, particularly in relation to the imminent threat of climate change and the pursuit of sustainable development. The country's unique composition, encompassing a diverse range of cultures and ethnicities, also contributes to its complex socio-cultural landscape. The objective was to provide empirical evidence on how the Djiboutian government could address an aging society within a fragile ecosystem. For this, several variables were selected, namely; renewable energy consumption, ecological footprint, trade, expenditures on the health sector, trade, and urbanization. And to address the data an autoregressive distributed lag (ARDL) model, a Granger causality test, and both an impulse response function (IRF) and variance decomposition (VD) analyses were employed.

Drawing upon the overall research, our findings demonstrate that, in Djibouti, government spending on healthcare plays a crucial role in addressing the healthcare requirements of the aging population. Nevertheless, the current level of government expenditure on healthcare is comparably inadequate compared to neighboring countries in the region. As a result, the accessibility and quality of healthcare services, particularly for the elderly, are constrained. While the impact of trade on the senior demographic initially presents promising outcomes, it is essential to acknowledge that the realization of these benefits is obstructed by entrenched inequality, persistent disparities, and a notable absence of impartiality, thereby undermining the positive potential of trade performance. Alternatively, ecological footprint, proxied as environmental deterioration
(the factor serves as a critical determinant that enhances our comprehension of the substantial ramifications it exerts on the elderly population in Djibouti and thereby facilitating the formulation and implementation of comprehensive measures) have projected a detrimental effect on senior well-being. On the other hand, it is interesting to note that there exists a noteworthy correlation between the utilization of renewable energy sources and the enhancement of well-being among the senior population. Similarly, urbanization positively affects Djiboutian seniors, ostensibly, as urban settings often offer better infrastructure and transportation systems, making it easier for the elderly to navigate and access essential resources, as well as offering a wide range of amenities and services that can cater to the specific needs of older adults.

In light of these findings, we recommend that the Djiboutian authorities take a proactive approach to address the complex interplay between demographic, economic, and environmental factors. This could involve implementing policies that promote sustainable energy solutions, while simultaneously addressing the ecological footprint of the country through measures such as reforestation, sustainable land use, and biodiversity conservation. Such efforts will be critical to ensuring a sustainable future for both the environment and the aging population in Djibouti. Policymakers must also evaluate several interconnected issues. The Djiboutian government should consider investing in green infrastructure that targets the needs of seniors. This might involve the creation of walkable areas with well-maintained pathways and crosswalks, as well as transportation networks that are convenient and budget-friendly to older individuals. Additionally, legislators may consider enacting rules that encourage the use of low-emission automobiles or electric vehicles, which would be beneficial to both older persons and the environment. It is also suggested that green technology be included in senior living facilities. This might include offering financial or tax breaks to encourage the adoption of energy-conserving appliances and the installation of solar panels or other renewable energy sources. Furthermore, governments should consider enacting rules aimed at encouraging the use of green building materials and designs, which could assist to cut energy expenses and promote sustainable living for older persons.

Furthermore, it is essential to emphasize the rising need for goods and services that appeal to older folks. This covers not just healthcare treatments, but also products and services that cater to the specific requirements and tastes of older consumers. Governments may encourage economic growth and employment while also meeting the requirements of aging demographics by encouraging the production and exportation of goods and services that appeal to the senior population. Another option is to promote tourism and other types of foreign trade that accommodate elderly people. This might involve creating age-friendly tourism locations that are accessible and safe for older tourists, as well as encouraging cross-border commerce in goods and services that appeal to older people. Governments may generate fresh economic possibilities and drive growth in critical areas of the market by capitalizing on the increasing demand for age-friendly products and services.

For budgetary implications, while taking into consideration the country’s income status, to encourage greater fiscal restraint and efficiency in government expenditure. This might include initiatives to eliminate waste and inefficiency in government expenditure, as well as actions to increase tax adherence and reduce corruption. Djiboutian government may guarantee that the nation’s resources are allocated more efficiently to fulfill the demands of aging populations by encouraging greater budgetary discipline and efficiency. It is also recommended to enhance expenditure on health and social protection programs for older individuals. This involves boosting spending for healthcare providers as well as social safety programs like pensions, disability benefits, and long-term care services. Governments may also assist to ensure that older individuals can receive the care and support they require by funding these programs, while also fostering economic growth and job creation in the healthcare and social protection sectors.
Finally, despite its contributions, the present article highlights various limitations. Firstly, the findings of this study can only be extrapolated to Djibouti and nations sharing a similar economic and structural framework with the Republic of Djibouti. Consequently, future research endeavors could adopt a comparative approach encompassing multiple African countries, particularly focusing on the distinctions between East and North African nations, while concurrently considering their income classifications. Additionally, to provide a comprehensive perspective on aging and culture, forthcoming investigations may explore the legal dimensions of the subject matter by incorporating an analysis of environmental legislation and accounting for corporate thresholds. Furthermore, this study employs specific econometric methodologies that primarily address association and potential shocks. Thus, it would be valuable for future research to employ alternative econometric approaches to expand upon the results obtained and explore their wider implications.

References


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