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**POPULATION, ENVIRONMENT AND CLIMATE CHANGE:**

# ENVIRONMENTAL QUALITY IN AFRICA: IS THE DEMOGRAPHIC DIVIDEND AN ASSET?

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## Abstract

In this article, we robustly show that the demographic dividend contributes to environmental degradation in Africa. To achieve this, we specify a model and then estimate it using panel data collected over the period 1975–2021 from a sample of 44 African countries, using several econometric techniques: Pooled Mean Group. Robustness is tested using fixed and random effects methods and Lewbell-2SLS. Our results indicate that the demographic dividend through trade liberalization, FDI, urbanization, and resource use increases deforestation, thereby further contributing to environmental degradation. On the other hand, through agricultural practices, the demographic dividend reduces the rate of deforestation, thereby improving environmental quality in Africa. We suggest that African states strengthen environmental education and awareness in order to cultivate a culture of sustainable lifestyles and environmental management among the population, thereby minimizing deforestation for environmental sustainability in Africa and enabling the achievement of the Sustainable Development Goals (SDGs).

Keywords: Deforestation, Demographic Dividend, Environmental Quality, Fixed Effect, Lewbell-2SLS, Random Effect, Pooled Mean Group.

## 1. Introduction

The renewed interest in the relationship between income and the environment, similar to the impact of the demographic dividend on environmental quality in Africa, is currently the subject of growing controversy. First, factors related to population dynamics overlap with environmental concerns (Xiao et al., 2022). Second, the ability of demographic variables to exacerbate or mitigate the impacts of climate change has sparked discussions on leveraging the demographic dividend to address environmental challenges (Koutika et al., 2022). Third, rapid urbanization and resulting changes in consumption patterns have sparked discussions about how demographic changes may affect environmental quality at the global, regional, and local levels (Olorunfemi et al., 2022). This debate highlights a broader recognition of the need to integrate demographic considerations into environmental policies and strategies. Essentially, a holistic approach that takes into account both demographic transformations and environmental sustainability is imperative to achieve a balance between economic progress and environmental preservation in Africa (Asongu et al., 2020; Nguea, 2023). By recognizing deforestation as an indicator of environmental quality (Cropper and Griffiths, 1994) and understanding the potential of the demographic dividend as an asset, it becomes clear that integrating demographic dynamics into comprehensive environmental policies and strategies is essential to achieving sustainable development goals in Africa.

According to FAO findings (2021), 26% of Africa's land is designated as forested, with the continent home to nearly 43 billion trees. Each year, nearly 4 million hectares of African forests are threatened with destruction, a rate almost twice the global average. At the same time, 66% of Africa is classified as arid regions. The arid climate that prevails in these desert areas results in tree cover representing approximately 17% of the total land area. Despite an overall reduction in deforestation rates in recent times, Africa continues to experience an increase in the loss of wooded areas, thereby compromising the resilience of the continent's ecosystems to climate change. There is no doubt that forests play a central role in maintaining environmental integrity, serving as vital watersheds, protecting land from soil erosion, regulating local climates, and capturing greenhouse gases (Martina Igini, 2022; Sacande et al., 2022).

Over the past 30 years, African countries have faced a myriad of challenges, including population growth, conflict, significant national debt, environmental disasters, and epidemics, all of which have had a profound impact on the continent's population and natural landscape (UNEP, 2023). In response to this difficult situation, many African countries are currently undertaking efforts, such as the New Partnership for Africa's Development (NEPAD), aimed at addressing some of the fundamental factors contributing to this environmental deterioration. However, these efforts remain insufficient. Harnessing Africa's demographic dividend presents both opportunities and challenges for improving environmental quality (Adedini et al., 2023). By addressing these challenges and capitalizing on the demographic dividend, Africa can move toward sustainable development and improved environmental quality (Yaziz et al., 2022). As shown in Figure 1, countries such as the DRC, Burundi, Côte d'Ivoire, Nigeria, Rwanda, Uganda, and South Africa are affected by increasing rates of deforestation (WDI, 2023). According to Kossi et al. (2021), this can be explained by the fact that, in addition to the high demand for land for agriculture, urban sprawl, sociopolitical conflicts, etc., there are certain rituals, including fire rituals and wood cutting in sacred groves (Havyarimana et al., 2018; Fandjinou et al., 2020; Suzzi-Simmons, 2023).

Deforestation in Africa is an urgent problem that has a significant impact on environmental quality and the promotion of sustainability. The depletion of forest resources not only leads to the eradication of natural habitats and a decline in biodiversity, but also plays a role in soil deterioration, limited water availability, and the impacts of climate change. Given the complex relationship between environmental adversities and demographic dynamics, the concept of the demographic dividend is gaining importance in Africa. The term demographic dividend refers to a phase during which the proportion of the working-age population in a country exceeds that of the dependent population, thereby promoting the potential for economic expansion and progress (Bloom et al., 2003). In 2021, Africa's population was estimated at approximately 1.2 billion people. Africa's annual population growth rate peaked at 3% in 1978 and remained above 2.8% throughout the 1980s. Since the 1980s, Africa has become the region with the fastest population growth. According to projections, Africa's population will nearly double, exceeding 2 billion by the end of the 2040s (WPP, 2022). The population of this geographical area is growing at an annual rate of 2.5%, the highest rate of the eight regions, more than three times the global average of 0.8% per year. With average fertility rates expected to reach nearly 3 births per woman by 2050, Africa is projected to contribute more than fifty percent of the global population increase between 2021 and 2050 (WPP, 2022).

Understanding population trends and forecasting demographic changes are essential for formulating national development strategies and implementing the 2030 Agenda for Sustainable Development. The 2030 Agenda emphasizes the central role of individuals in sustainable development, reflecting the principles set out in the program of action of the International Conference on Population and Development (ICPD) established in Cairo in 1994 (WPP, 2022). The unique shape of the age pyramid of the African population is influenced by several factors, as shown in Figure 2. First, the age distribution of the African population has undergone significant changes in recent decades (Pillay and Maharaj, 2012). This demographic shift makes Africa a demographic superpower, with growing geopolitical and economic influence on the global landscape (Harpur and Ngalomba, 2016). In addition, subnational variability in the age structure of the population reflects different levels of development, which has an impact on economic prospects and health issues on the continent (Wilson, 2016; Pezzulo et al., 2017). Africa's relatively young demographic structure plays an important role in shaping its age pyramid (Mougeni et al., 2020). Furthermore, Africa's population has grown rapidly, with more than 1 billion people in 2020, and a significant proportion of people under the age of 15. The number of people aged 60 and over is increasing, and projections indicate that by 2050, this age group will represent about 9% of the African population, up from 5% currently (Kaba, 2020). Finally, these factors collectively contribute to the distinct shape of the age pyramid observed in the African population, highlighting the importance of understanding demographic dynamics for effective policy formulation and planning (Muza and Mangombe, 2019; Widayani et al., 2020).

Numerous studies have highlighted the complex nature of the relationship between the demographic dividend and environmental quality. Nevertheless, a crucial aspect of these discussions recognizes the existence of inclinations that encompass both pessimistic and optimistic perspectives. Clydesdale (2018) posits that these debates center on Kuznets' environmental curve (ECK) hypothesis regarding deforestation. Thünen (1826) asserts that population growth and urbanization lead to increased demand for arable land, resulting in the conversion of forests into agricultural areas. Similarly, increased labor and efficiency can promote economic progress and urban expansion, thereby increasing pressure on forests to convert land, accelerating the rate of deforestation, and contributing to environmental degradation. López (1994) points out that as incomes rise, deforestation decreases when the implications of forest resources on agricultural production are internalized. It is therefore assumed that as incomes rise, the rate of deforestation decreases, thus encouraging the population to improve its forest reserves and the quality of the environment. Corroborating this notion by invoking the concept of forest transition, Perz (2007) asserts that the decline in forest cover is an inevitable repercussion of nations' development trajectories. During the early stages of development, population growth and food needs exert significant pressure on forested areas due to agricultural expansion; subsequently, as nations progress, the growing demand for forest-related products and equipment stimulates the reforestation process, driven by key political entities (Barbier et al., 2010; Yeo and Huang, 2013).

As shown in Figure 3, the demographic dividend is positively correlated with deforestation and therefore with environmental quality in Africa (WDI, 2023). One way in which the demographic dividend can have a positive correlation with environmental quality, particularly in terms of deforestation, is through changes in consumption patterns. When countries benefit from the demographic dividend and their economies grow, individuals may have more disposable income to purchase goods and services (Pautrel, 2009). This increased consumption can stimulate demand for products linked to deforestation, such as timber, palm oil, and beef. However, as countries progress through their demographic transition and become more economically developed, they often shift toward service industries and away from resource-intensive industries such as logging and agriculture. This structural transformation can lead to lower rates of deforestation as countries move toward more sustainable economic activities. Furthermore, when countries experience economic growth due to the demographic dividend, they can invest more in conservation efforts and sustainable development practices (Mulugeta Woldegiorgis, 2023). These may include initiatives to protect forests, promote reforestation, and implement policies to reduce deforestation rates.

This study makes several contributions to the existing literature in four areas. First, it is one of the first investigations into the role of the demographic dividend as a factor hindering environmental quality. Second, it leads to economic policy proposals for African policymakers regarding the potential of African youth. Third, it is based on a rigorous methodology that is well suited to the available data. To this end, we use new instrumental variable techniques, such as the Lewbell-2SLS method, to resolve potential endogeneity issues. And fourthly, by using deforestation as an indicator of environmental quality (Cropper and Griffiths, 1994), the study highlights the impact of demographic factors on the natural environment, emphasizing the interconnection between demographic trends and environmental sustainability. Following this introduction, the rest of the document is structured as follows. Section 2 briefly reviews the literature. Section 3 describes the methodological strategy. Section 4 presents the empirical results. Section 5 discusses the results. Conclusions and policy implications are presented in Section 6.

## 2. Literature review

This section addresses two important points. First, the development of a theoretical fusion is explored, followed by a concise empirical evaluation.

### 2.1. Theoretical synthesis of the effects of the demographic dividend on environmental quality.

The theoretical debate on the link between the demographic dividend and environmental quality is complex and the subject of much discussion within the academic community. Two schools of thought have emerged from this debate: those who espouse the traditional view and those who espouse the modern view.

The first group of theories recognizes the presence of both pessimistic and optimistic trends. Malthus's theory on population or demographic growth and resource scarcity (1798) argues that population expansion puts pressure on arable land, forcing the use of agricultural land. Environmental degradation, in a global context, to create more agricultural land, forests are often cleared, contributing to deforestation. Thünen's theory of land rent for deforestation (1826) suggests that as populations grow and urbanize, the demand for agricultural land increases, leading to the conversion of forests into agricultural areas. Similarly, increases in labor and productivity can stimulate economic development and urbanization, further intensifying pressure on forests for land conversion, which increases the rate of deforestation, thereby contributing to environmental degradation. The economic theory of value developed by Smith (1776), Riccardo (1817), Marx (1867), Menger (1871), Jevons (1871), Walras (1874), etc., explains how the value of goods and services is determined. While classical economists focused on labor and production costs, neoclassical economists emphasized subjective utility and scarcity. Modern economics incorporates these perspectives, recognizing that value is influenced by a combination of factors, including consumer preferences, production costs, and market dynamics. Whitaker's (1940) contribution on land use and human-environment interactions argues that it is important to understand the interconnectedness of ecosystems and the need to adopt sustainable resource management practices. Because demographic dynamics can play a role in both the destruction and conservation of natural resources, as the population grows and urbanizes, the demand for resources such as wood, water, and land increases, putting greater pressure on ecosystems. This can lead to deforestation, pollution, habitat destruction, and other negative impacts on environmental quality. Boserup's theory of agricultural development (1965) argues that population dynamics stimulate innovation and agricultural intensification. It addresses the relationship between demographic change and agricultural intensification, as well as deforestation, supporting land use and agricultural practices that promote environmental degradation. Ehrlich's (1968) socio-ecological argument in the field of resource management, environmental sustainability, and population studies in his book “The Population Bomb” emphasizes that population growth exerts enormous pressure on natural resources, leading to environmental degradation and resource depletion. The demand for agricultural land causes widespread deforestation and habitat destruction, hence the need to control population growth. Bilsborrow (1987), supporting this view, emphasizes the impact of demographic trends on land use and agricultural productivity, as population growth and distribution influence development. These complex interactions between demographic dynamics, land use, and agricultural productivity can contribute to deforestation when farmers expand into forest areas to meet growing food demand, resulting in environmental degradation and even biodiversity loss.

These theories have facilitated the illustration of population dynamics alongside external disturbances, encompassing economic, social, environmental, institutional, ideological, and political determinants, as well as technological influences. The effects of the demographic dividend on environmental quality are the subject of much debate that transcends generational divides. While growing populations exert significant pressure on limited resources, the expansion of agricultural land increases in parallel, leading to deforestation, which in turn exacerbates environmental degradation (Rudel et al., 2009). Such deforestation can cause soil erosion, disrupt hydrological cycles, and precipitate habitat loss, which can lead to decreased agricultural productivity and worsening food shortages. As populations continue to grow and economies expand, demand for agricultural land, urban sprawl, and resource extraction increase accordingly. Regions that take advantage of the demographic dividend may experience an increase in the working-age population, which could lead to increased agricultural production, urbanization, and industrial development (Thisse, 2002; DeFries et al., 2010). Other arguments are worth considering. Primarily, in developing countries, particularly those in Africa characterized by a young and thriving workforce, forests are frequently cleared to create agricultural land due to the labor-intensive nature of primary agriculture. Furthermore, in areas experiencing a demographic dividend, the perceived benefits of converting forests to agricultural or urban land often outweigh the perceived value of preserving forests, particularly when forests are considered abundant or of limited economic importance. Furthermore, low labor and land costs often make deforestation an economically viable strategy for meeting growing demand for food, housing, and infrastructure. In addition, forests are often destroyed to optimize land productivity for agricultural or development purposes, as these activities are considered more financially lucrative. However, in some regions, farmers have adopted more intensive practices, such as agroforestry and irrigation, to increase yields without clearing additional land. Finally, contemporary economic theories emphasize the concept of opportunity cost with regard to resource use. Forest preservation entails an opportunity cost associated with lost agricultural or developmental benefits; however, deforestation entails long-term costs related to environmental degradation and the loss of ecosystem services (Meyfroidt et al., 2013).

With the emergence of the new economy in the 1990s, the second group, known as the modern foundation, emerged from this debate. The theory of land tenure and restoration focuses on how property rights, land tenure systems, and institutional frameworks influence land use decisions, resource management, and environmental restoration efforts (Ostrom, 1990; Bromley, 1991; Chhatre and Agrawal, 2009). A growing working-age population increases demand for agricultural land, housing, and infrastructure, leading to deforestation and thus degrading environmental quality. Uncertain or unclear land tenure exacerbates deforestation, as individuals and communities lack incentives to manage land sustainably, contributing to land degradation (Chigbu, 2023). López (1994) provides a theoretical analysis of the "Kuznet environmental curve (ECK) for deforestation," indicating that as incomes rise, deforestation decreases when the impacts of forest resources on agricultural production are internalized. Therefore, it is assumed that as income increases, the rate of deforestation decreases, thereby incentivizing the population to improve their forest resources and the quality of the environment. Munasinghe (1999) proposes that a harmonious balance between the economy and the environment throughout the development phase would be optimal, leading to a mutually beneficial solution through the Kuznet environmental curve theory for deforestation. In this perspective, Culas (2007) emphasizes that factors associated with agricultural productivity, demographic dynamics, economic factors, and government strategies in each region are presumed to influence deforestation and, consequently, environmental well-being. Therefore, institutions that guarantee property rights and implement improved environmental strategies to steer the system toward sustainable progress can mitigate the slope of Kuznets' environmental curve (ECK) between income and deforestation (Motel et al., 2009). Critically, Arrow et al. (1995) argue that economic growth or income is not a universal remedy for environmental concerns; economic and environmental strategies are not interchangeable, let alone demographic dividend policies. Echoing this view, Bhattarai and Hammig (2001) emphasize that the irreversible consequences of environmental degradation, such as biodiversity loss due to deforestation, must be fully recognized; it is therefore imperative to recognize a critical threshold in the development process. In another extension, Mather's (1992) forest transition argues that as countries, using population dynamics, develop economically, they move from deforestation to reforestation. This transition occurs when industrialization and urbanization lead to a decrease in demand for agricultural land and greater importance is placed on environmental conservation. Reinforcing this idea, Perz (2007) argues that the decrease in forest cover is an inevitable effect of the development process in countries. At the beginning of development, population growth and food demand will put significant pressure on forest land due to agricultural expansion. Then, as countries develop, growing demand for forest products and services stimulates the reforestation process, driven by political institutions that play an important role (Barbier et al., 2010; Yeo and Huang, 2013; Ceddia et al., 2013).

### 2.2. Empirical synthesis of the effects of the demographic dividend on environmental quality.

Several hypotheses have been put forward in the academic literature to elucidate the impacts of the demographic dividend on environmental quality (Mariani et al., 2019). First, a group of explanations on the positive effects of the demographic dividend on environmental quality (Washington and Kopnina, 2022). Zhang et al. (2018) on a study "How does demographic structure affect environmental quality?" Empirical evidence in China" using a panel of 29 Chinese provinces over a period from 1995 to 2012, employing the econometric estimation technique of the generalized method of moments (GMM), find that overall, the demographic structure improves environmental quality. Van Dao and Van (2020) conducted a study titled "The Impact of Population Growth on the Environment: A Brief Review" covering the period 1990-2018. This study focused on the two main cities of Vietnam, namely Hanoi and Ho Chi Minh City. The authors used the DPSIR model (Driving forces - Pressure - State - Impact - Response) and concluded that population dynamics, combined with cultural factors, had a positive impact on the quality of the environment in these two cities. By studying "the analysis of the economic impact on environmental degradation in Indonesia" over a period from 1965 to 2019, Yuswinarto and Gunanto (2021), using the dynamic time series method with autoregressive distributed lag (ARDL), found that population dynamics contribute to the improvement of environmental quality. Chaurasia and Chaurasia (2020) conducted a study titled "Effects of Population on the Environment" which focuses on the period from 1990 to 2030. They analyzed a sample of 186 countries worldwide, with particular attention to India, using the IPAT model. The results of their research suggest that long-term demographic dynamics can positively contribute to the improvement of environmental quality.

Following that, on the other hand, a group elucidating the negative effects of the demographic dividend on environmental quality. Magnani and Tubb (2008) analyzing "the link between economic growth and environmental quality: what is the role of demographic changes?" on a panel of 30 member countries of the Organisation for Economic Co-operation and Development (OECD), over a period from 1970 to 2002. Using econometric estimation techniques of fixed and random effects, they find that demographic change can increase pollution emissions while having a negative impact on reduction expenditures. By studying "Population and Lifestyle Changes in China: Implications for Environmental Quality" over the period from 1978 to 2012 using the weighted semi-parametric least squares estimation technique (WSLS), Apergis and Li (2016) found that demographic changes and changes in consumption behavior have significantly contributed to the degradation of environmental quality during the periods under study. Nica et al. (2019), in studying "the influence of population growth on the environment" with a sample of countries worldwide for the period 1990 – 2017, using descriptive statistical analysis, find that population growth contributes to the worsening of environmental degradation. Dimnwobi et al. (2021) in their study "Population Dynamics and Environmental Quality in Africa" on a sample of 5 African countries for the period 1990 – 2019, using econometric techniques of Cross-sectionally Augmented Autoregressive Distributed Lag (CS-ARDL), find that population dynamics further exacerbate environmental degradation.

Finally, a last group exposing the mixed effects of the demographic dividend on environmental quality. Cropper and Griffiths (1994), in a study on "interactions between population growth and environmental quality," based on a sample of 64 developing countries during the period 1961-1988, using the fixed effects econometric estimation technique, found that macroeconomic relationships are often misinterpreted, indicating that rapid income growth alone is not sufficient to solve environmental problems, contrary to what is generally accepted, particularly in Latin American and African countries. The results highlight the implicit importance of a trade-off between per capita income, population density, and land property rights that must be resolved. Jain and Jain (2016) in their study "Population and Development: Impacts on Environmental Performance," based on a sample of 128 countries worldwide for the year 2011, using the eukaryotic non-model annotation pipeline (EnTAP model), found that technological development and population size have a negative impact on environmental performance, while measures aimed at improving wealth have a positive impact. Technological development has increased the production of energy-efficient products, but at the same time, the consumption of these products has multiplied, leading to environmental deterioration. Demographic characteristics must be given special attention to improve environmental performance. Rahman (2017) studying "does population density, economic growth, energy consumption, and exports have a negative impact on environmental quality in high-population Asian countries?" on a sample of 11 countries for the period from 1960 to 2014, using econometric estimation techniques including the fully modified ordinary least squares (FMOLS) method and dynamic ordinary least squares (DOLS), they find that energy consumption, exports, and population density have a negative impact on environmental quality in the long term. The study also identified a one-way relationship in the short term between energy consumption, gross domestic product (GDP), exports, and CO2 emissions, and highlighted a bidirectional causality between GDP and population density. Moreover, a long-term bidirectional causality was observed among the considered variables. In their study "Influence of Demographic Structure and Industrial Growth on Environmental Quality," Khan et al. (2021) focus on the countries of the South Asian Association for Regional Cooperation (SAARC) during the period 1985-2016, using the "Stochastic Impact by Regression on Population, Affluence, and Technology (STIRPAT)" framework. They find that a negative linear coefficient is observed for industrial expansion. On the other hand, the positive quadratic coefficient validates the presence of the inverted U-shaped Kuznets curve in SAARC member countries. Similarly, factors such as the working-age population (demographic composition), urbanization, and trade are negative indicators of environmental quality.

Overall, the theories as discussed in the above development, observed in different regions, support both that as societies undergo demographic and economic transitions, there is a strong desire for a shift from deforestation to forest restoration, and thus to better environmental quality, under the influence of economic changes, land policies, and technological advantages (Xiong et al., 2021; Estoque et al., 2022). The demographic dividend could play a crucial role in this change and in promoting sustainable development by giving countries the opportunity to invest in environmental conservation (Oliveira, 2018). To our knowledge, few studies have analyzed this issue in the existing literature, which is why this study has the privilege of investigating the role that the demographic dividend can play in improving environmental quality in Africa.

### 2.3. Analysis of Transmission Channels

The literature identifies several channels, considered here as mediators, through which the demographic dividend transits to influence the quality of the environment. This includes agricultural practices, resource use, urbanization, trade openness, and foreign direct investment.

#### 2.3.1. Agricultural Practices

From a theoretical standpoint, agricultural practices contribute to deforestation, primarily through the conversion of forest lands into agricultural lands, thereby influencing the quality of the environment. It is a complex economic issue that involves trade-offs between short-term economic gains and long-term environmental sustainability (Apoorva and Kundlas, 2024). Several key factors support this observation. First, subsistence agriculture, in developing regions, small farmers often clear land to grow food to survive. The same applies to commercial agriculture. Next, shifting cultivation, traditional practices such as slash-and-burn agriculture in certain regions, lead to deforestation. Finally, land issues, weak property rights, and lack of clarity in land ownership can encourage deforestation (Ayeni and Olagoke-Komolafe, 2024). However, agricultural expansion can also bring benefits. The contribution of agroforestry, which involves the integration of trees into agricultural landscapes, offers several environmental benefits in carbon sequestration, improves soil health, biodiversity conservation, and water conservation (Sarkar et al., 2024; Fatima et al., 2024; Yaseen et al., 2024; Chiaffarelli et al., 2024; Sadowski et al., 2024).

#### 2.3.2. Resource use

According to the literature, the relationship between resource use and deforestation, as well as environmental quality, is complex and multifaceted. Two axes emerge from this dynamic. First, logging and timber extraction contribute significantly to deforestation. In many tropical countries, demand for wood and other forest products has led to overexploitation of forest resources, often resulting in environmental degradation (Atangana et al., 2024; Seydewitz et al., 2023). Second, artisanal and industrial mining are also important drivers of deforestation. Industrial mining often requires large areas of extraction, leading to direct clearing of forests. Similarly, artisanal and small-scale mining, particularly for gold, has been associated with significant forest loss. Beyond the immediate clearing of mining sites, the activity often leads to broader environmental degradation. A study of mining in 26 countries found that while direct deforestation is concentrated in a few countries, indirect deforestation occurs in tropical countries (Giljum et al., 2022). In addition to this negative impact of resource use on deforestation and environmental quality, according to the literature, sustainable resource use practices play a crucial role in mitigating deforestation and environmental degradation. These practices aim to strike a balance between human needs and environmental conservation, ensuring that natural resources are used in a way that preserves the health and biodiversity of ecosystems (Fatima et al., 2024).

### 2.3.3. Urbanization

Urbanization has a complex and multifaceted impact on deforestation, which is often used as an indicator of environmental quality. The relationship between urbanization and deforestation can vary depending on the region, level of development, and policies in place. The literature suggests that urbanization plays a crucial role in influencing deforestation and thus environmental quality (Clement et al., 2015). As cities grow, natural habitats, including forests, are often cleared to make way for urban development (roads, highways, railways, etc.), which has numerous environmental consequences. Urbanization contributes to deforestation through mechanisms such as direct land conversion and infrastructure development (Zipperer et al., 2020). For example, in a study in India, the conversion of forest land to urban areas was linked to increased greenhouse gas emissions and decreased air quality (Pokhariya et al., 2024). However, urban planning strategies can play a crucial role in mitigating these negative effects. By prioritizing sustainability, urban planners can design cities that minimize the impact on natural habitats and promote environmental quality. Strategies such as green infrastructure and urban greening, sustainable urban design and architecture, preservation of natural habitats and biodiversity, community engagement, etc. (Li, 2024).

### 2.3.4. Trade liberalization

Trade liberalization influences deforestation and thus environmental quality in various ways, depending on a country's context, policies, and economic structures. Two distinct groups of influence can be identified: those who argue for negative effects and those who argue for positive effects (Du et al., 2024). For the first group, trade liberalization often increases demand for agricultural exports (e.g., soybeans, palm oil, beef, etc.), leading to the conversion of forests into agricultural land. This is particularly evident in developing countries with abundant natural resources. In addition to this consideration, free trade can encourage the exploitation of natural resources, such as timber and minerals, leading to deforestation (Kustanto, 2022). In some cases, countries may lower their environmental standards to attract foreign investment or remain competitive in global markets, which exacerbates deforestation. On the other hand, the second group argues that trade liberalization can lead to specialization in industries where a country has a comparative advantage. If a country specializes in land-intensive industries, it can reduce pressure on forests. In addition, free trade can facilitate the transfer of environmentally friendly technologies and practices such as sustainable agriculture and forest management, which can mitigate deforestation (Abman et al., 2024).

### 2.3.5. Foreign direct investment

The effect of foreign direct investment (FDI) on deforestation, understood as environmental quality, is a hotly debated issue in economics. According to the literature, this relationship depends on several factors, which may include the host country's policies and economic incentives. From a theoretical and empirical perspective, several debates have emerged. First, the pollution haven hypothesis (Antweiler et al., 2001) suggests that FDI moves from developed to developing countries because of less stringent environmental regulations in the latter. Multinationals may invest in sectors such as agriculture, mining, or forestry, which can accelerate deforestation. If FDI is aimed at extracting natural resources, it can lead to: large-scale land clearing for mining or oil exploitation; the expansion of agricultural activities such as palm oil, soybean cultivation, or livestock farming; and increased logging activities for timber exports (Cole et al., 2006). Second, the Kuznets environmental curve suggests that as economies develop through FDI, environmental degradation initially worsens but then improves after reaching a certain income level. In this context, FDI could initially lead to deforestation, but then promote environmental conservation through: better forest management; investment in sustainable industries; and the adoption of green technologies (UNCTAD, 2020). Finally, FDI can strengthen economic growth, leading to increased urbanization, infrastructure development, and agricultural expansion, which can contribute to deforestation. However, higher income levels can also lead to better environmental policies and reforestation efforts (Meyer, 2018; Farooq et al., 2025).

## 3. Methodological strategy

To analyze the quantitative aspect of the relationship between the demographic dividend and environmental quality in Africa, this section aims, first, to present the theoretical and empirical model. Second, it describes the data and explains the estimation technique.

### 3.1. From the theoretical model to the empirical model

Few studies have empirically examined the relationship between the demographic dividend and environmental quality in Africa (Nguea, 2023). The basic framework used is based on Kuznets' environmental curve (EKC) for the empirical estimation of this study. Although most previous studies on the relationship between demographic variables and the environment have been based on the IPAT model proposed by Ehrlich and Holdren (1971), which in turn has been criticized for its weaknesses compared to the EKC framework (Hassan and Salim, 2015). Supported by the study by Liddle (2015) and Yaziz et al. (2022), this study adopts the EKC model for its advantages in studying the impact of various factors in addition to IPAT. Thus, by applying the multiple linear regression model, Yaziz et al. (2022) specify a model as follows:

$$CO_{2it} = f\left(GDP_{it}, GDP_{it}^2, EC_{it}\right) \quad (1)$$

Where $CO_2$ represents carbon dioxide emissions per capita, $GDP$ is real gross domestic product per capita, $GDP^2$ represents real gross domestic product per capita squared, and $EC$ represents energy consumption per capita. The indices $i\ and\ t$ represent the country and the time dimension within a panel. Studying the link between population aging and CO2 emissions without neglecting the vitality of income and the energy aspect on environmental quality, after transformation, Yaziz et al. (2022) propose a model specified in natural log-linear form, integrating other factors as follows:

$$lnCO_{2it} = \alpha + \beta_1\ lnGDP_{it} + \beta_2\ lnGDP_{it}^2 + \beta_3\ lnELC_{it} + \beta_4\ lnPA_{it} + \varepsilon_{it} \quad (2)$$

Where $CO_{2it}$ represents emissions $CO_2$ per capita, $GDP_{it}$ this refers to GDP per capita, $GDP_{it}^2$ represents real gross domestic product per capita squared, $ELC_{it}$ is the per capita electricity consumption and $PA_{it}$ is the proportion of the population aged 65 and over in the total population. $\alpha \ et \ \beta$ correspond respectively to the values of the constant and elasticity. The indices $i \ and \ t$ refer respectively to the country and year, and $\varepsilon_{it}$ is the error term.

We take this linear equation from Yaziz et al. (2022) by incorporating our analysis variables. We rewrite this equation and replace the dependent variable with environmental quality, captured here by a proxy, which is deforestation (Cropper and Griffiths, 1994). The variable of interest thus becomes the demographic dividend. Equation (2) is therefore specified as follows:

$$ln\mathrm{QUALENV}_{it} = \alpha + \beta_1 \, ln\mathrm{DD}_{it} + \beta_2 \, ln\mathrm{GDP}_{it} + \beta_3 \, ln\mathrm{NGIE}_{it} + \beta_4 \, ln\mathrm{POP}_{it} + \beta_5 \, \mathrm{DEMOC}_{it} + \varepsilon_{it} \quad (3)$$

Where $ln\mathrm{QUALENV}_{it}$ represents environmental quality, $ln\mathrm{DD}_{it}$ the demographic dividend, $ln\mathrm{GDP}_{it}$ GDP per capita taken as income, $ln\mathrm{NGIE}_{it}$ energy consumption, $ln\mathrm{POP}_{it}$ total population, $\mathrm{DEMOC}_{it}$ democracy and $\varepsilon_{it}$ is the error term. The indices i and t refer respectively to the country and year, and α and β correspond respectively to the values of the constant and elasticity. The $\beta_1$ to $\beta_5$ are parameters to be estimated.

### 3.2. Data and estimation techniques.

Various definitions of variables and data sources are presented in this section. The research was conducted on a panel of 44 African countries. The annual data covers the period from 1975 to 2021. This period was chosen because the 1970s were a significant period in the history of environmental awareness and environmental policy, which led to growing recognition of the interaction between environmental quality and population dynamics. It was also a period that saw the emergence of many non-governmental environmental organizations[1]. The sample selected was determined by the availability of data series, as well as by the issue of deforestation that characterizes developing countries, particularly those in Africa. Table 1 presents information on descriptive statistics, which elucidate the general characteristics of the variables used in the study. An examination of Table 1 reveals that, in general, the standard deviation is lower than the mean, indicating a low dispersion of variables in the sample. It is also accepted that low data fluctuations lead to unbiased results. The quality of the environment in African countries is characterized by an average rate of 3.574%, with minimum values of 0.894% corresponding to Egypt and maximum values of 4.425% corresponding to South Africa. The data also show that the selected countries have significant demographic dividend rates. The average rate is 4.468%. The minimum rate is 3.699% for Mauritius, and the maximum rate is 4.815% for Niger. It should be noted that some indicators show variability, as indicated by the standard deviation values. The correlation between the variables is presented in Table 2.

Table 2 shows that the demographic dividend has a negative correlation with environmental quality. The independent variables have a rather mixed association with environmental quality: some are negatively correlated, while others are positively correlated. In addition, we find evidence of multicollinearity among the selected independent variables. The Variance Inflation Factor (VIF) values for all independent variables are presented in the appendix.

[1] Greenpeace (fondée en 1971) et le Worldwatch Institute (fondé en 1974) figurent parmi les organisations qui ont vu le jour au cours de cette période.

Numerous previous studies have revealed that environmental quality is affected by several variables. In the context of this study, the following variables caught our attention:

- Dependent variable:

*Environmental quality* (QUALENV): refers to the overall state of the environment, including air, water, soil, and biodiversity quality, as well as the sustainability of natural resources (Mensah et al., 2021). There are several measures of environmental quality, including deforestation (Cropper and Griffiths, 1994), CO2 emissions (Avom et al., 2020), and ecological footprint (Dimnwobi et al., 2021), all of which are influenced by human activities. For Cropper and Griffiths (1994), considering deforestation as a proxy in the analysis of environmental quality is a better indicator of the reality in developing countries, particularly those in Africa (Rudel, 2023). The World Bank's development indicators database provided these data (WDI, 2023).

- Variable of interest:

*The demographic dividend (DD)* is a concept that describes a phase of economic expansion that can occur when a country's working-age population exceeds its dependent population, which consists of children and the elderly (Bloom and Williamson, 1998; United Nations, 2013). It is calculated using the World Population Prospect formula, i.e. ((Pop aged 0 to 14 + Pop aged 65 and over) / (Pop aged 15 to 64)). This is then improved by incorporating the unemployment rate, becoming ADJUSTED: ((Pop aged 0 to 14 + Pop aged 65 and over) / (Pop aged 15 to 64)*(1-k)), where k is the unemployment rate. The demographic dividend can also influence environmental quality (Yaziz et al., 2022). In cases where a country experiences economic expansion and increased efficiency due to a larger working-age population, levels of industrialization, urbanization, and resource use may increase (Zhang et al., 2018; Asongu et al., 2020). As a result, this situation can lead to environmental problems such as air and water pollution, deforestation, habitat loss, and increased greenhouse gas emissions. These data are from the World Bank Development Indicators database (WDI, 2023).

- Control variables:

*Gross domestic product, here taken as income* (GDP): is an economic indicator frequently used to quantify the total monetary value of goods and services generated within a country's borders over a given period, usually on an annual or quarterly basis (WDI, 2023). As a measure of a country's economic output and overall economic health, it does not directly take into account the quality or sustainability of the environment. Traditional GDP growth generally comes at the expense of environmental quality and resource depletion. It can also contribute to its improvement (Jain and Jain, 2016; Khan et al., 2021). These data are from the World Bank Development Indicators database (WDI, 2023).

*Energy consumption* (ENERGY): This is the equivalent in kilograms of oil of energy consumption per constant PPP GDP. Energy consumption corresponds to the use of primary energy before conversion into other end-use fuels, which is equal to domestic production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport (WDI, 2023). Apergis and Li (2016) argue that energy consumption has an influence on environmental quality. These data come from the World Bank Development Indicators database (WDI, 2023).

*Population* (POP): refers to the total population of a country, which includes all residents regardless of their legal status or citizenship (WDI, 2023). Population size and growth can have a significant impact on environmental quality. When the population of a region increases, the demand for resources such as water, energy, and land increases, leading to increased pressure on the environment (Baus, 2017; Dimnwobi et al., 2021; Udemba et al., 2024). These data are from the World Development Indicators database (WDI, 2023).

*Democracy* (DEMOC): represents a system of governance in which authority is conferred on the population, either through direct participation or through elected representatives. In a democratic framework, individuals have the privilege of participating in the formulation of choices that affect their lives. Farzin et al. (2006) and Akalin and Erdogan (2021) argue that a democratic system allows for greater citizen participation and accountability in decision-making processes that impact the environment. These data are from the Variety Democracy (VDEM) database (Nord et al., 2024).

The model is estimated primarily using the Pooled Mean Group (PMG) method. This estimation technique was chosen because of its practical advantages. On the one hand, the Pooled Mean Group (PMG) estimator allows for the efficient processing of dynamic panels, particularly those for which the number of time observations T is as large as the number of individuals N (Pesaran et al., 1999). On the other hand, it offers the possibility of estimating a long-term relationship between different variables, without prior precautions regarding stationarity or even the existence of a cointegration relationship between them. To do this, the estimation is based on the assumption that the model constant, as well as the short-term coefficients and error variances, may differ across individuals, but that the long-term coefficients are identical. Using the notation of Pesaran et al. (1999), we set out the principle of the method formally below. Let us consider a sample of N individuals observed over T periods, with $(N, T) \in N \; x \; N$. We consider the ARDL model $(p;\; q_1; \ldots\; ;\; q_k)$ following:

$$y_{it} = \sum_{j=1}^{p} \lambda_{ij}\, y_{i,t-j} + \sum_{j=0}^{q} \delta'_{ij}\, X_{i,t-j} + \mu_i + \varepsilon_{it} \qquad (1)$$

$$i = 1, 2, \ldots, N\;; t = 1, 2, \ldots, T$$

Where $X_{it}$ is a matrix of explanatory variables in format $(k \; x \; 1)$ ; $\mu_i$ represents individual fixed effects ; the $\lambda_{ij}$ are coefficients assigned to individual lagged dependent variables $(y_{i,t-j})$, and $\delta'_{ij}$ is a matrix of scalars of format $(k \; x \; 1)$.

Equation (1) can be reformulated to obtain an error-corrected representation expressed in the following equation:

$$\Delta y_{it} = \Phi_i y_{i,-1} + X_i \beta_i + \sum_{j=1}^{p-1} \lambda^{*}_{ij}\, \Delta y_{i,-j} + \sum_{j=0}^{q-1} \delta^{*}_{ij}\, \Delta X_{i,t-j} + \mu_i + \varepsilon_{it} \qquad (2)$$

By stacking all observations for each individual « i », equation (2) is equivalent to the following equation (3):

$$\Delta y_{it} = \Phi_i y_{i,-1} + X_i \beta_i + \sum_{j=1}^{p-1} \lambda^{*}_{ij}\, \Delta y_{i,-j} + \sum_{j=0}^{q-1} \Delta X_{i,t-j}\, \delta^{*}_{ij} + \mu_i \tau + \varepsilon_{it} \qquad (3)$$

Where $y_i = (y_i1, y_i2, \dots, y_iT)'$ is a matrix of format $(T\ x\ 1), X_i = (X_i, \dots, X_iT)'$ a matrix of format $(T\ x\ k), and\ \tau = (1, 1, \dots, 1)'$ is a matrix of format $(T\ x\ k)$. The following assumptions underlie the model described in equation (3):

- Disturbances $\varepsilon_{it}$ are independently and identically distributed white noise. They are also independent of the regressors $X_{it}$.

- Equation 3 is stable. This requires that we have $\Phi_i < 0$, i.e., the roots of the operator polynomial $\sum_{j=1}^{p} \lambda_{ij}\, z^j$ lie outside the unit circle, reflecting the existence of a long-term relationship between the level variables. This relationship is expressed by the following equation:

$$y_{it} = -(\beta_i'/\Phi_i)X_{it} + \eta_{it} \qquad (4)$$

Where $\eta_{it}$ is a stationary process.

- The coefficients are homogeneous in the long term. In the short term, however, the coefficients may differ between individuals. Formally, in the long term we have:

$$\theta_i = \theta = -\beta_i/\Phi_i \qquad (5)$$

Under the three previous assumptions, equation (3) can still be written as follows:

$$\Delta y_i = \Phi_i \Gamma_i(\theta) + W_i K_i + \varepsilon_i \qquad (6)$$

Où $\Gamma_i(\theta) = y_{i,-1} - X_i\theta$ is the error correction term,

$$W_i = \left(\Delta y_{i,-1}, \dots, \Delta y_{i,-p+1}, \Delta X_{i,-1}, \dots, \Delta X_{i,-q+1}, \tau\right)\ et\ K_i = (\lambda_{i1}^*, \dots, \lambda_{i,p-1}^*, \delta_{i0}^{*'}, \dots, \delta_{i,q-1}^{*'}, \mu_i)'$$

The model estimator, particularly for long-term coefficients, is calculated using the maximum likelihood method based on the following likelihood function (Pesaran et al., 1999):

$$e(\gamma) = -\frac{T}{2}\sum_{i=1}^{N} \ln 2\pi\sigma_i^2 - \frac{1}{2}\sum_{i=1}^{N} \frac{1}{\sigma_i^2}(\Delta y_i - \Phi_i\Gamma_i(\theta))'\, D_i(\Delta y_i - \Phi_i\Gamma_i(\theta)) \qquad (7)$$

Où $D_i = I_T - W_i(W_i'W_i)^{-1}W_i^{-1}, \gamma = (\theta', \Phi', \sigma'), \Phi' = (\emptyset_1, \emptyset_2, \dots, \emptyset_N)', et\ \sigma' = (\sigma_1^2, \sigma_2^2, \dots, \sigma_N^2)$.

The estimators for short-term and long-term coefficients, as well as adjustment coefficients, are obtained by maximizing the log-likelihood function (7) with respect to $\gamma$. The maximization process is carried out iteratively, starting from an initial value $\hat{\theta}^{(0)}\ of\ \theta$, that allows the estimators of the adjustment coefficients and individual variances to be determined. These, in turn, allow a new value to be calculated $\hat{\theta}^{(1)}$ and so on until the maximum is obtained..

The main reason for choosing this estimator is its compatibility with variables with different orders of integration, such as I (0), I (1), or a combination of these in the context of the variables examined. This gives the autoregressive distributed lag (ARDL) approach a notable advantage, as it avoids the need for and importance of performing unit root tests. In addition, it allows for the simultaneous estimation of short- and long-term effects in the analysis. The potential presence of endogeneity, particularly in the ARDL model using Pool Mean Group (PMG) estimators, ensures the robustness of the coefficients by incorporating lags in the dependent and independent variables. Throughout this procedure, all estimators take into account the long-term equilibrium, with the heterogeneity of the dynamic adjustment process being assessed using maximum likelihood techniques. The ARDL model, implemented with an error correction mechanism, is a relatively recent technique for cointegration analysis; nevertheless, it is essential to ensure consistent and efficient parameter estimates in order to establish a sustainable relationship. The preliminary tests used to select the PMG estimator are presented in the appendix.

## 4. Results and discussions

The basic results, followed by the robustness results, are presented in this section.

### 4.1. Basic results

Table 3 presents the results of the demographic dividend's effects on environmental quality in Africa. Three versions of the Pooled Mean Group (PMG) estimator are used: Pooled Mean Group (PMG, column 1), Dynamic Fixed Effect (DFE, column 2), and Mean Group (MG, column 3). The results show that the PMG estimator has the highest overall effect on environmental quality, with the DFE estimator having the second highest effect. The MG estimator has the lowest effect. All models are stable in terms of the model's recall strength, which is significant and negative in econometric form. The table shows two trends, a short-term relationship and a long-term relationship. We are interested in the long-term relationship, which is the distinctive feature of the PMG estimator.

With regard to the long-term relationship, the PMG results show an overall positive relationship between the demographic dividend (lnDD), GDP per capita (lnGDP), energy consumption (lnENERGY), population (lnPOP), democracy (DEMOC), and deforestation (lnENVIRONMENTAL QUALITY) at different levels of significance. Firstly, with regard to the demographic dividend, a 1% increase in the demographic dividend leads to a 0.367% increase in deforestation in Africa. This result is consistent with the findings of Angelsen and Kaimowitz (1999) and Pautrel (2009). Indeed, without claiming to be exhaustive, several reasons can support this relationship. First, the increase in the working-age population (synonymous with the demographic dividend) increases the demand for agricultural land, housing, and infrastructure. In many African countries, this demand is met by clearing forests. Second, the demographic dividend often leads to increased economic activity, which can accelerate land use change (commercial agriculture, mining, logging, etc.). In addition, in many African countries, weak enforcement of environmental regulations and property rights exacerbates deforestation. Finally, poverty remains a challenge even with a demographic dividend. Poor households may depend on forests for subsistence activities such as collecting firewood or slash-and-burn agriculture, which exacerbates deforestation, thereby contributing to environmental degradation (Geist and Lambin, 2002).

Secondly, in terms of income (lnGDP), a 1% increase in income leads to a 0.090% increase in deforestation in Africa. This result is consistent with the conclusions of Ehrhardt-Martinez et al. (2002). Indeed, without claiming to be exhaustive, there are many reasons that may support this influence. First, as economic activity grows, high income levels can increase demand for agricultural products, prompting farmers to clear forests to cultivate land. Second, Kuznets' environmental curve hypothesis suggests that environmental degradation first increases with economic growth and then decreases once a country reaches a higher income threshold. The positive coefficient of 0.090% suggests that Africa is still in the early stages of Kuznets' environmental curve, where economic growth leads to increased deforestation rather than environmental improvement. Finally, despite rising incomes, governance issues can exacerbate deforestation, thereby contributing to environmental degradation (Karsenty and Ongolo, 2012; Acheampong et al., 2019).

Thirdly, with regard to energy consumption (lnENERGY), a 1% increase in energy consumption leads to a 0.174% increase in deforestation in Africa. This result is in line with the conclusions of the work of Fritsche et al. (2017). Indeed, without claiming to be exhaustive, there are several reasons that may explain this relationship. First, in many African countries, energy consumption still relies heavily on biomass, with firewood and charcoal accounting for a significant share of household and industrial energy consumption. This is particularly true in rural areas where access to modern energy sources (e.g., electricity, natural gas) is limited (IEA, 2022). Second, factories and production units can require large amounts of energy, often from biomass or fossil fuels, leading to land clearing for energy production. Finally, the construction of energy infrastructure, such as hydroelectric dams and electricity grids, can lead to large-scale forest loss (Karsenty and Ongolo, 2012).

Fourth, with regard to population (lnPOP), a 5% increase in population leads to a 0.098% increase in deforestation in Africa. This result is consistent with the findings of Asongu and Jingwa (2012). Indeed, without claiming to be exhaustive, this relationship can be explained by the fact that population growth is widely recognized as one of the main drivers of deforestation in Africa. Previous studies, such as those by Rudel (2023), show that as the population increases, so does the demand for agricultural land, firewood, and other forest products, leading to the clearing of forests and contributing to the degradation of the environment. In addition to this consideration, population growth, combined with poverty, increases dependence on forests for subsistence. This includes the use of forests for food, medicine, and fuel, which exacerbates deforestation rates (Kowero et al., 2013).

And fifthly, with regard to democracy (DEMOC), a 1% increase in democracy leads to a 1.542 unit increase in deforestation. This result is consistent with the work of Akalin and Erdogan (2021). Indeed, without claiming to be exhaustive, there are multiple reasons that may support this relationship. First, the poor functioning of democracy can contribute to increased deforestation and thus to the degradation of environmental quality. Second, leaders of democratic African countries are subject to electoral pressures and may prioritize short-term economic gains at the expense of long-term sustainability. To win votes, politicians may authorize deforestation for agricultural and infrastructure projects that generate jobs and income. In addition, in many African democracies, institutional quality suffers from the lack of enforcement of laws on land and property rights. Corruption in forest management allows illegal logging to continue despite democratic institutions. Finally, some African democracies experience political instability, which can disrupt environmental governance and lead to increased deforestation during periods of conflict or weak governance, thereby contributing to environmental degradation (Barrett et al., 2006; Burgess et al., 2012).

This result is similar when the DFE estimator is used (column 2). However, the coefficients for the demographic dividend, energy consumption, and population variables are high. In the literature, demographic pressure and energy consumption are factors that destabilize environmental quality (Cropper and Griffiths, 1994; Muza and Mangombe, 2019; Widayani et al., 2020; Mulugeta Woldegiorgis, 2023). The difference between PMG and DFE can be explained. PMG is based on the assumption that the coefficients are the same for the different subsets of the population. In contrast, DFE does not make this assumption and allows the coefficients to vary across subsets. This could explain why the demographic dividend coefficient was higher when using DFE. Indeed, DFE allows the coefficients to vary across subsets and takes into account different factors that may influence the results. It is therefore able to take into account demographic differences and other factors that may influence the results, whereas the PMG does not. The DFE is therefore more flexible and able to capture the effect of different demographic groups more accurately. This provides a more nuanced view of the effect of the demographic dividend on deforestation, and thus on environmental quality, than the PMG model.

### 5.2. Robustness analysis

So far, we have shown that the demographic dividend has a positive impact on environmental quality in African countries. We also perform three robustness analyses to ensure the validity of these results and identify the channels through which the demographic dividend affects environmental quality in Africa.

#### 4.2.1. Taking into account the alternative variable of the demographic dividend.

Table 4 presents the results of the effects of the demographic dividend on environmental quality in Africa, observing the effect of the alternative measure of the demographic dividend. Three versions of the Pooled Mean Group (PMG) estimator are used: Pooled Mean Group (PMG), Mean Group (MG), and Dynamic Fixed Effect (DFE). In terms of results, the PMG estimator has the highest overall effect on environmental quality, while the DFE estimator has the second highest overall effect. The MG estimator has the lowest overall effect. The different models are broadly stable in terms of the strength of the recall, which is significant and negative from an econometric point of view. Two trends are observed: a short-term relationship and a long-term relationship. We focus our attention on the long-term relationship, which is the distinctive feature of the PMG estimator. Looking at the long-term relationship, the PMG results reveal that the demographic dividend has a positive sign on deforestation, which further exacerbates environmental degradation in Africa (Allen and Barnes, 1985). This result is similar when using the DFE estimator.

#### 4.2.2. Change in estimation technique: Fixed effects and random effects

Table 5 presents the results of the demographic dividend effect on environmental quality in Africa, using a new estimation method. After taking into account individual effects that vary over time using PMG, DFE, and MG estimators, the fixed and random effects method (Mundlak, 1961; Balestra and Nerlove, 1966) is used, which has the advantage of correcting for any bias resulting from autocorrelation between individual effects and explanatory variables in the sample. The fixed effects estimator is preferred to the Hausman test found in the appendix. Table 5 reveals that the demographic dividend, at the individual level, encourages deforestation, thereby contributing to greater environmental degradation in Africa. Indeed, without claiming to be exhaustive, the increase in the working-age population generates many economic factors that can contribute to escalating rates of deforestation. First, the growth of the working population leads to increased demand for agricultural production, requiring the expansion of land for commercial and subsistence agriculture, as well as the proliferation of commercial crops, all of which accelerate deforestation (Angelsen and Kaimowitz, 1999; Acheampong et al., 2019). Second, the growth of the working-age population stimulates urban sprawl, intensifying demand for timber and construction materials (Seto et al., 2012). Finally, this population increase creates competition for land, water, and forest resources, leading to problems related to the tragedy of the commons (Hardin, 2018).

#### 4.2.3. Endogeneity Issues

In this subsection, an analysis of the potential omitted variable bias as a source of endogeneity is first presented, and finally, the results of the endogeneity corrections using the Lewbel two-stage least squares estimation technique (2SLS-Lewbel) are presented.

##### 4.2.3.1. Omitted variable bias.

Although fixed effects models are interesting due to their ability to regulate the temporal determinants of the demographic dividend and environmental quality, they remain insufficient as global determinants of these phenomena. Elucidating the cause-and-effect relationship between the demographic dividend and environmental quality presents considerable challenges. More specifically, the fixed effects estimator reveals an inconsistency in the presence of omitted time factors, which are related to the demographic dividend and influence environmental quality. To address the issue of omitted variable bias, the bounds analysis proposed by Oster (2019) was used.

The dominant perspective in the literature holds that bias related to omitted variables is mitigated when the coefficient remains stable after the addition of control variables. However, Oster emphasises the importance of considering the R-squared statistic, as the coefficient may remain stable even if non-informative control variables are added. The methodology proposed by Oster helps reduce omitted variable bias, allowing for a partial identification of causal relationships through a comparative analysis between "uncontrolled" and "controlled" regression models, based on a set of defined hypotheses regarding the interaction between observable and unobservable selection factors.

Table 6 presents the Oster (2019) test, which shows that the value 0 is excluded from the interval [0.0739; 158.701]. This indicates that there is no endogeneity problem related to omitted variables in the model. Moreover, this confirms the relevance of the selected variables as determinants of environmental quality. However, endogeneity can also arise from other sources, such as measurement errors or reverse causality of the variables. That is why the use of robust estimation techniques, such as 2SLS-Lewbel, has been considered.

##### 4.2.3.2. Solving the endogeneity problem: the 2SLS-Lewbel method

Taking into account the issue of endogeneity leads us to use Lewbel's 2SLS estimation method (2012). Unlike the application of the instrumental variable methodology, the Lewbel technique allows for a certain degree of robustness in the results. Indeed, identifying appropriate instruments that simultaneously meet these required conditions is often difficult, which constitutes a considerable obstacle to the application of estimators using instrumental variables in most empirical research (Baum et al., 2012; Stock et al., 2002). To address this challenge, the present study employs Lewbel's robust two-stage least squares (2SLS) technique, which is particularly relevant when identification sources, such as valid external instruments, are not available or are weak. The Lewbel 2SLS methodology is crucial for the identification of structural parameters in regression models that contain an endogenous or mismeasured regressor in the absence of classical identification information. This technique incorporates internal instruments derived from heteroscedasticity. The internal instruments are produced from the residual values of the auxiliary equation, which are then multiplied by each of the exogenous variables in a mean-centered format. A notable advantage of the 2SLS-Lewbel technique is that it is not subject to the adherence to standard exclusion restrictions.

Table 7 presents the results of the effect of the demographic dividend on environmental quality in Africa, using a new estimation method, the 2SLS-Lewbel method, which facilitates the correction of the potential endogeneity problem that may exist in the model. The displayed results reveal that the demographic dividend has a positive and significant effect at the 1% level on deforestation in Africa. An increase of 1% in the demographic dividend would lead to an increase in deforestation in Africa by 0.952%, thereby contributing to the degradation of environmental quality. These results align with those obtained in Table 5.

#### 4.2.4. Addition of other control variables

Table 8 presents the results of the effects of the demographic dividend on environmental quality, with the addition of other control variables likely to influence environmental quality. Table 8 shows several relationships. First, the demographic dividend has a positive and significant effect at the 1% threshold on deforestation. A 1% increase in the demographic dividend would lead to a 4.288% increase in deforestation in Africa, thereby exacerbating environmental degradation. These results are consistent with those obtained in Table 7.

Second, the resource use variable (UTILRESS) has a negative and significant effect at the 1% threshold on deforestation. A 1% increase in resource use is associated with a -0.387% decrease in deforestation (improvement in environmental quality) in Africa. This result is consistent with the conclusions of Ikeke (2021). Indeed, without claiming to be exhaustive, resource use generally involves the extraction or exploitation of natural resources such as timber, minerals, or agricultural land. In many African countries, these activities are directly linked to deforestation, as forests are cleared for logging, agriculture, or mining. However, the negative coefficient suggests that increased resource use is associated with a reduction in deforestation. This counterintuitive result may reflect several underlying economic mechanisms. First, technological progress. Increased resource use may be accompanied by technological improvements or more efficient resource management practices. Second, economic development. Greater resource use could lead to better environmental regulations, better enforcement, and investments in conservation. In addition, substitution effects. Abundant use of resources (e.g., minerals) may reduce dependence on another resource (e.g., wood), which could lead to lower deforestation rates. Finally, policy interventions. Governments and/or international organizations may implement practices aimed at curbing deforestation in response to increased resource use, such as protected area designations or payments for ecosystem services (Luke, 2025).

Third, urbanization has a positive and statistically significant effect at the 1% threshold on deforestation in Africa. A 1% increase in urbanization would lead to a 0.106% increase in deforestation on the continent. This result is consistent with the findings of Seto et al. (2012). Indeed, without claiming to be exhaustive, as urban areas expand in Africa, the quality of the environment, as measured by deforestation, deteriorates. Several mechanisms can explain this relationship. First, urbanization often requires land for infrastructure, housing, and industrial activities, leading to the clearing of forests to accommodate this growth. Second, urban populations consume more resources, such as wood, agricultural products, and energy, which can cause deforestation through forest expansion, agriculture, and firewood collection. In addition, urban centers act as hubs for economic activities that depend on natural resources, such as mining and large-scale agriculture, thereby exacerbating deforestation. Finally, in many

African countries, weak enforcement of environmental policies can encourage uncontrolled urban expansion and resource exploitation, contributing to deforestation and environmental degradation (Jayathilake et al., 2021).

Fourth, with regard to trade openness (lnOUVCOM), this has a positive and statistically significant effect at the 1% threshold on deforestation in Africa. This means that a 1% increase in trade openness would lead to a 0.768% increase in deforestation. This result is consistent with the findings of Mustapha et al. (2025). Indeed, without claiming to be exhaustive, several mechanisms can explain this relationship. First, trade openness often encourages countries to exploit their natural resources to stimulate exports and economic growth. In Africa, where many economies depend on these resources, increased trade can increase demand for timber, agricultural products, and minerals. This demand leads to deforestation, as forests are cleared for logging, agriculture, and mining activities. Second, many African countries have relatively weak environmental regulations or enforcement mechanisms. Trade liberalization can exacerbate deforestation if it leads to increased economic activity without adequate measures to protect forests. Weak policies or controls would allow companies and individuals to engage in unsustainable practices, such as illegal logging (Shu et al., 2024). In addition, the scale effect of economic growth plays an important role. Trade liberalization stimulates economic growth, which can increase the scale of production and consumption. This scale effect can lead to increased resource extraction and deforestation, especially if growth is concentrated in sectors that are heavily dependent on natural resources. In addition, trade liberalization often requires the development of infrastructure, such as roads, ports, and railways, to facilitate the movement of goods. While such infrastructure is essential for trade, it can also open up access to previously inaccessible forest areas for exploitation. Finally, in some cases, trade liberalization can exacerbate income inequalities and prevent large segments of the population from escaping poverty. Poor communities may resort to deforestation for subsistence agriculture or firewood, having no other means of livelihood. This short-term survival strategy contributes to long-term environmental degradation (Pham and Nguyen, 2024).

And fifth, foreign direct investment (FDI) has a positive and significant effect at the 1% threshold on deforestation in Africa. This means that a 1% increase in foreign direct investment would lead to a 3.930% increase in deforestation in Africa. This result is consistent with the conclusions of the work of Doytch et al. (2024). Indeed, without claiming to be exhaustive, there are multiple explanations that can support this relationship. First, a significant portion of FDI in Africa is directed toward resource-intensive sectors such as mining, logging, and large-scale agriculture. These sectors often require the clearing of large areas of forest to access natural resources or establish operations. Second, FDI in agriculture and agribusiness can lead to large-scale changes in land use, with forests being converted into agricultural land or industrial zones. This could lead to the acquisition of large tracts of land for commercial agriculture, displacing local communities and accelerating deforestation, thereby contributing to environmental degradation. Finally, African countries, in their efforts to attract foreign direct investment, may implement lax regulations, in this case the pollution haven hypothesis, which suggests that multinationals from developed countries relocate their polluting industries to countries where environmental regulations are less strict (Larcom et al., 2016; Hershaw and Sauer, 2023).

After establishing the link between the demographic dividend and environmental quality in Africa, a study was conducted on the specific effects of the demographic dividend on environmental quality (understood as deforestation). Table 9 presents the results of the effect of the demographic dividend (lnDD) on deforestation in Africa, focusing on the role of potential channels through which the demographic dividend influences deforestation, including agricultural practices (lnPRATIQAGRIC), resource use (lnUTILRESS), urbanization (lnURBANIS), trade openness (lnOUVCOM), and foreign direct investment (lnIDE). The results shown in Table 9 indicate that, first, the demographic dividend associated with agricultural practices (lnDD*lnPRATIQAGRIC) has a positive and statistically significant effect at the 1% threshold on deforestation in Africa. This means that a 1% increase in the association between the demographic dividend and agricultural practices leads to a 0.009% increase in deforestation in Africa. This result is consistent with the findings of Ryan et al. (2017). Indeed, without claiming to be exhaustive, there are several reasons to support this relationship. Many African countries are benefiting from a demographic dividend due to declining fertility rates and the growth of the young population. The increase in the working-age population leads to increased demand for jobs and income-generating activities. In agrarian economies, this often translates into an expansion of agricultural practices, as agriculture remains the main source of income. This dynamic means that a larger working-age population turns to agricultural activities, leading to deforestation to create new arable land. Furthermore, faced with constraints on access to modern technologies that could increase the productivity of existing agricultural land, many African countries choose to expand their cultivated areas to increase production, which contributes to deforestation and thus to the degradation of environmental quality (Pendrill et al., 2022).

Secondly, with regard to the interaction between the demographic dividend and resource use (lnDD*lnUTILRESS). The latter has a negative and significant effect at the 1% threshold on deforestation in Africa. This means that a 1% decrease in the interaction between the demographic dividend and resource use would lead to a 1.310% decrease in deforestation in Africa. This result is consistent with the conclusions of Aune (1993). Indeed, without claiming to be exhaustive, several reasons can support this relationship. First, a larger, better educated, and more productive working-age population could promote policies for investment in sustainable land use, reforestation projects, and conservation programs. Second, this interaction suggests that in economies experiencing a demographic dividend, resource use becomes more efficient or is offset by other economic activities. Finally, increased labor productivity could lead to better agricultural techniques (e.g., intensification) or a shift to less destructive industries (Cleaver and Schreiber, 1995; Asongu and Jingwa, 2012).

Third, the interaction between the demographic dividend and urbanization has a positive and statistically significant effect at the 1% threshold on deforestation in Africa. A 1% increase in this interaction would lead to a 0.0344% increase in deforestation in Africa. This result is consistent with the findings of DeFries et al. (2010). Although not exhaustive, there are several possible explanations for this finding. First, a larger working-age population can boost economic productivity, but its impact on deforestation depends on the allocation of labor. If labor flows to urban industries, this can reduce direct pressure on forests. On the other hand, if urbanization is resource-intensive, it can indirectly increase deforestation. Furthermore, this positive effect of the interaction between the demographic dividend and urbanization suggests that a growing urban workforce increases demand for natural resources, agricultural products, wood, and energy, leading to increased forest clearing to meet this production. Finally, rapid urbanization requires the creation of new roads, new settlements, and new industrial zones, to the detriment of forests (Sylvester et al., 2024).

And fourthly, the interaction between the demographic dividend and foreign direct investment has a positive and statistically significant effect, at the 10% threshold, on deforestation in Africa. A 10% increase in this interaction would lead to a 0.116% increase in deforestation. This result corroborates the conclusions of the work of Piabuo et al. (2024). Several explanations can be put forward to support this relationship. First, agricultural expansion and resource exploitation, particularly through FDI in agribusiness (such as palm oil, cocoa, and soybeans), can cause massive conversion of forests into arable land. The demographic dividend provides an abundant and inexpensive labor force, facilitating deforestation for commercial agriculture. Second, FDI often finances infrastructure (roads, dams, mines) that opens up previously inaccessible forest areas. In some African countries, FDI focuses on the extraction of natural resources (timber, minerals), facilitated by a young and available workforce. Finally, governments may relax environmental regulations or sacrifice forests to attract FDI (Arthur et al., 2024).

### 4.2.5. Taking regional observations into account

Tables 10 and 11 present the results of the demographic dividend effect (lnDD) on deforestation (lnQUALENV) in Africa, highlighting this impact by geographical region, including North Africa, Central Africa, West Africa, Southern Africa, and East Africa. The effect of the demographic dividend varies significantly from one region to another. First, it has a positive and significant effect at the 1% threshold on deforestation in North Africa, with a coefficient of 4.508%. Next, it is also positive and significant at the 1% threshold on deforestation in Central Africa, with a coefficient of 0.640%. However, it is negative and statistically significant at the 5% threshold in West Africa, with a coefficient of -0.900%. Furthermore, it is positive and significant at the 10% threshold for deforestation in Southern Africa, with a coefficient of 0.248%. Finally, it is positive and significant at the 1% level for deforestation in East Africa, with a coefficient of 0.640%. These results are in line with the conclusions of the work of Xiao et al. (2022). Several explanations can support these results, although this list is not exhaustive. The effect of the demographic dividend on deforestation varies across regions, influenced by factors such as population density, economic structure, and governance. Regions with weak regulations and high population growth are particularly vulnerable to deforestation. Regional differences in geography and culture shape land use practices and environmental outcomes (Nguea, 2023).

## 5. Discussions

This study analyzed the effects of the demographic dividend on environmental quality (here understood as deforestation) in Africa. It also took into account the ways in which the demographic dividend influences environmental quality. The study showed positive and significant effects of the demographic dividend on deforestation, thus demonstrating its contribution to the degradation of environmental quality in Africa. Its effect becomes mixed when associated with agricultural practices, urbanization, and foreign direct investment (FDI). More specifically, it increases deforestation when associated with agricultural practices, urbanization, and FDI. On the other hand, it reduces the rate of deforestation when associated with resource use and trade openness.

According to Angelsen and Kaimowitz (1999), Geist and Lambin (2002), and Pautrel (2009), a multitude of factors can explain this correlation. First, the expansion of the working-age population (assimilated to the demographic dividend) increases the demand for agricultural land, residential properties, and infrastructure development. In many African countries, this growing demand is often met by deforestation of wooded areas. Second, the demographic dividend generally leads to an increase in economic activity, which can accelerate changes in land use (including commercial agriculture, mining, and forestry). In addition, in several African countries, inadequate enforcement of environmental legislation and property rights intensifies the incidence of deforestation. Finally, poverty remains a significant obstacle, despite the existence of a demographic dividend. Poor households may depend on forest resources for subsistence activities such as collecting firewood or slash-and-burn agriculture, which exacerbates deforestation and, as a result, contributes to environmental degradation (Pendrill et al., 2022).

## 6. Conclusion

African countries have the potential to reap the benefits of a demographic dividend through targeted, effective, and coordinated policies that respond to environmental circumstances. However, consideration of temporal coherences between demographic and forest transitions for environmental quality is necessary for dynamic equilibrium in socio-ecological contexts that facilitate positive outcomes (Franco-Henao et al., 2018; Chen et al., 2023).

This manuscript was formulated with the aim of studying the impacts of the demographic dividend on environmental conditions in Africa. To achieve this objective, a first step was to conduct a comprehensive analysis of the existing theoretical and empirical literature to identify the research problem. The review revealed that considerable attention had been paid to the demographic dividend by researchers, mainly focusing on economic aspects. Nevertheless, it is imperative to take environmental factors into account when examining the demographic dividend. Therefore, particular emphasis was placed on the environmental repercussions of the demographic dividend in the African context. This article is part of the demo-economic theory, incorporating concepts such as Kuznet's environmental curve and land rent for deforestation, as well as the theory of forest transition. It should be noted that it emphasizes the interaction between the demographic dividend and environmental well-being. Empirical evidence, using pooled mean group estimators, fixed effects, and random effects, was analyzed to assess the influence of the demographic dividend on environmental quality in a panel of 44 African countries from 1975 to 2021. The results indicate that the demographic dividend exacerbates environmental degradation in Africa.

Nevertheless, to reap the potential benefits of the demographic dividend on environmental quality in Africa, it is essential to implement supportive policies and make strategic investments. Governments and relevant stakeholders are encouraged to prioritize the development of sustainable agricultural techniques to mitigate deforestation, soil degradation, and water contamination, while simultaneously improving food security and rural livelihoods. Encouraging the adoption of green technologies and innovations through tax breaks and incentives can stimulate economic growth while mitigating environmental damage. In addition, strengthening education and innovation initiatives through fiscal support can promote economic development while reducing environmental impact. It is also essential to strengthen environmental education and awareness in order to cultivate a culture of sustainable living and environmental stewardship among the population. The implementation of economic incentives such as payment for ecosystem services (PES) can encourage local communities and landowners to conserve forests and natural habitats. Furthermore, investing in renewable energy infrastructure is essential to reduce dependence on fossil fuels and facilitate the transition to cleaner energy sources.

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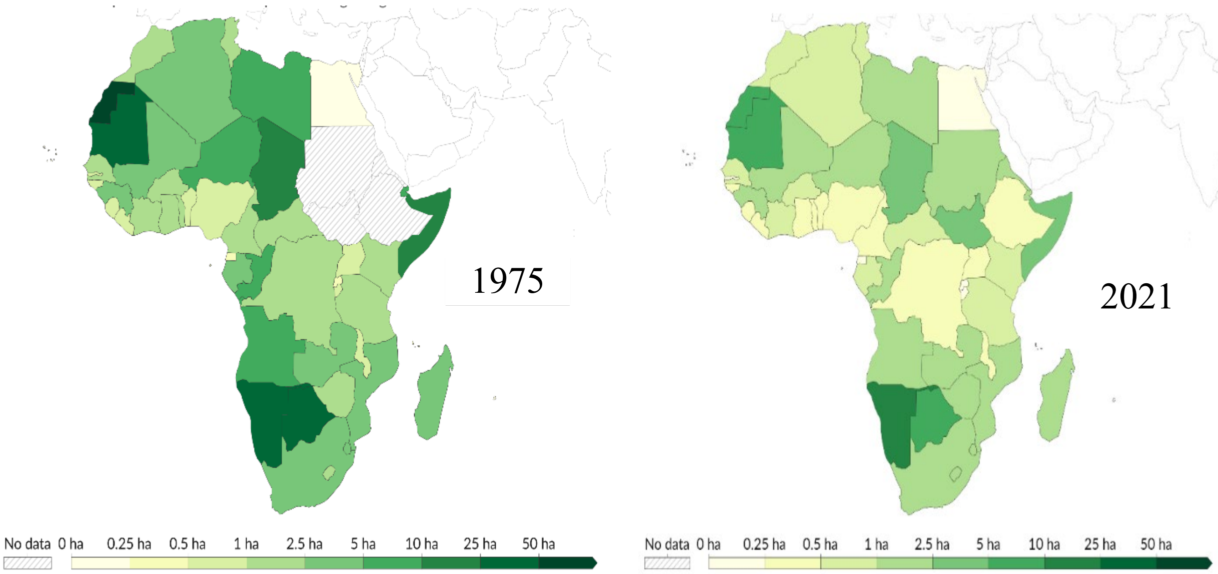
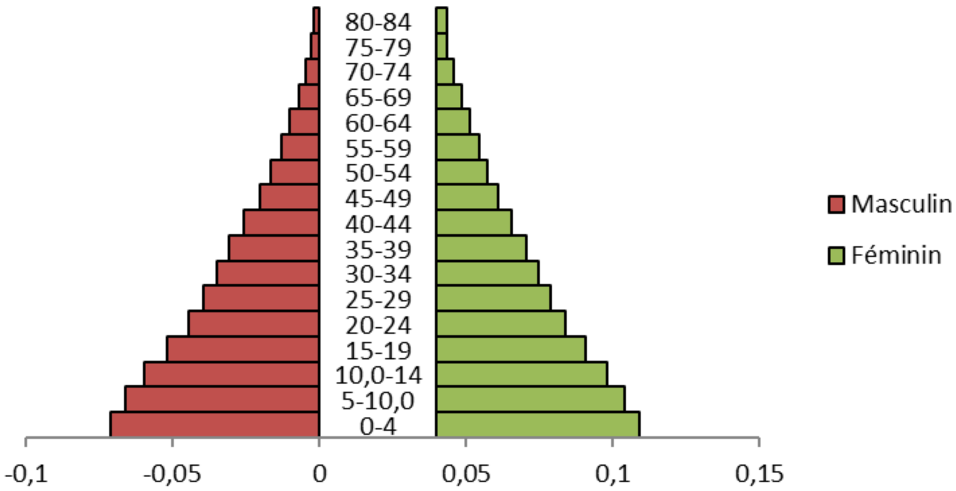
Figure 1. La cartographie de la qualité de l'environnement en Afrique entre 1975 et 2021.



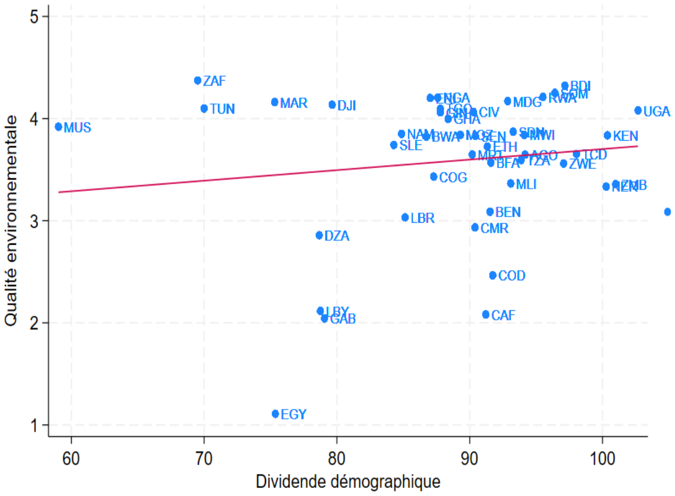

Source : Auteurs, à partir de World in data (2023)

Figure 2 : Pyramide des âges de la population africaine 2000 à 2021



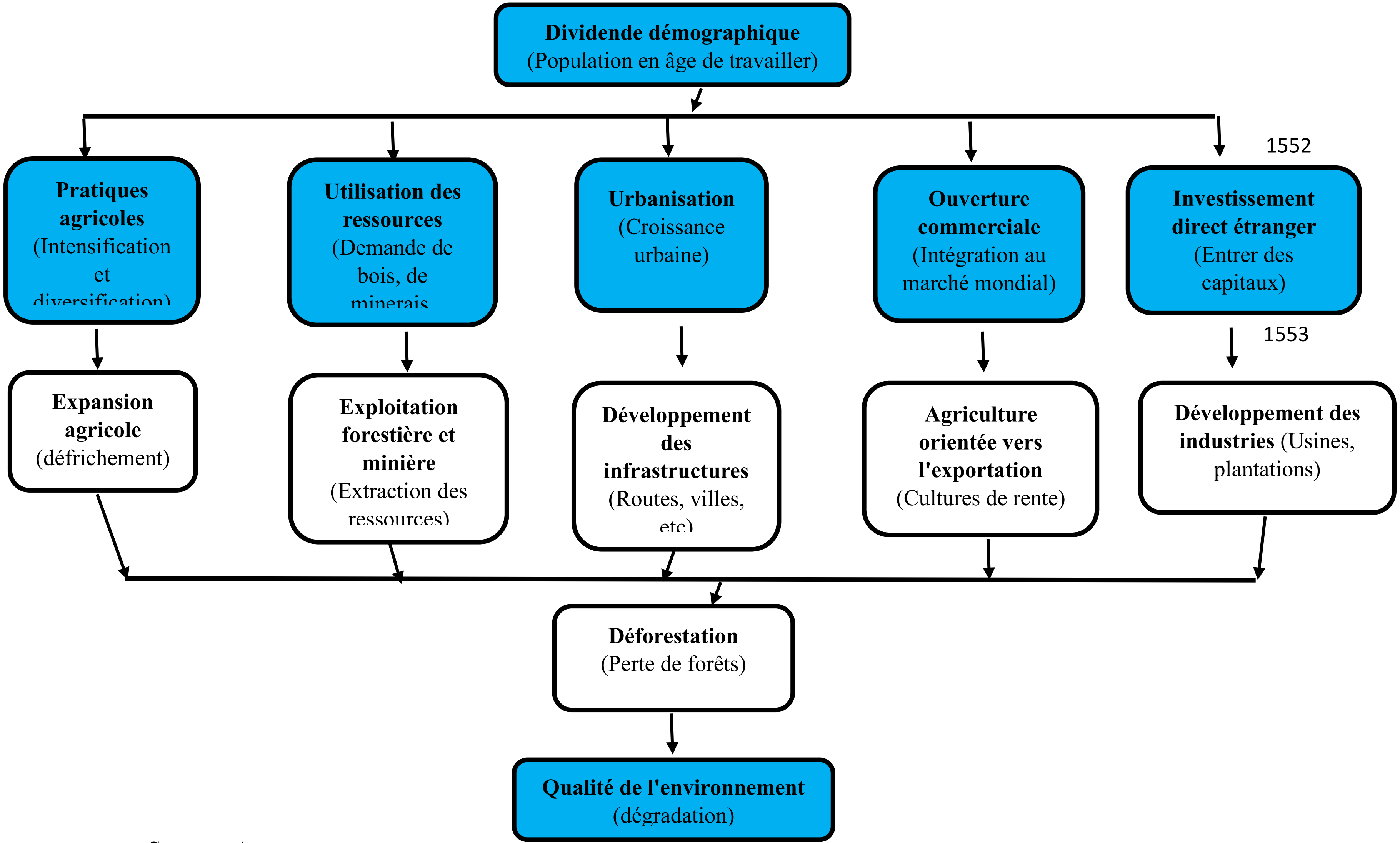

Source : Auteurs, à partir des données de World population prospect (WPP, 2022).

Figure 3. Corrélation entre le dividende démographique et la qualité environnementale en Afrique.




Source : Auteurs

Figure 4. Influence du dividende démographique sur la qualité de l'environnement en Afrique.




Source : Auteurs.

Tableau 1. Statistiques descriptives

| Variables | Observations | Moyenne | Ecart-types | Minimum | Maximum |
|---|---|---|---|---|---|
| QUALENV | 2608 | 3,574 | 0,712 | 0,894 | 4,425 |
| DD | 2728 | 4,468 | 0,177 | 3,699 | 4,815 |
| DDAJUSTE | 2666 | 4,511 | 0,152 | 3,765 | 4,872 |
| PIB | 2309 | 6,998 | 0,900 | 5,119 | 9,628 |
| ENRGIE | 1199 | 6,315 | 0,632 | 4,728 | 8,118 |
| POP | 2718 | 15,845 | 1,256 | 11,334 | 19,169 |
| DEMOC | 2727 | 0,286 | 0,187 | 0,009 | 0,789 |
| PRATIQAGRIC | 2105 | 2,998 | 0,780 | -0,004 | 4,370 |
| UTILRESS | 2069 | 1,807 | 1,540 | -11,595 | 4,191 |
| URBANIS | 2728 | 3,294 | 0,694 | 0,731 | 4,504 |
| OUVCOM | 2123 | 0,592 | 0,301 | 0,008 | 3,480 |
| IDE | 2019 | 3,414 | 0,375 | -12,364 | 4,883 |

Source : Auteurs

Tableau 2. Matrice de corrélation

| Variables | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| (1) QUALENV | 1.000 | | | | | |
| (2) DD | -0.004 | 1,000 | | | | |
| (3) PIB | -0.159 | -0,570 | 1,000 | | | |
| (4) ENRGIE | -0.119 | -0,460 | 0,705 | 1,000 | | |
| (5) POP | -0.005 | 0,105 | -0,316 | -0,103 | 1,000 | |
| (6) DEMOC | 0.230 | -0,341 | 0,174 | 0,086 | -0,181 | 1,000 |

Source : Auteurs

Tableau 3 : Effet du dividende démographique sur la qualité environnementale en Afrique.

| | (1) | (2) | (3) |
|---|---|---|---|
| VARIABLES | PMG | DFE | MG |
| **ec** | **-0.051**** | **-0.043***** | **-0.495***** |
| | **(0.024)** | **(0.009)** | **(0.067)** |
| | **Relation de court terme** | | |
| D_lnDD | 0.332 | -0.015 | 1.080** |
| | (0.219) | (0.085) | (0.517) |
| D_lnPIB | -0.003 | 0.002 | -0.006 |
| | (0.030) | (0.014) | (0.029) |
| D_lnENRGIE | -0.008 | 0.035** | -0.226 |
| | (0.051) | (0.016) | (0.296) |
| D_lnPOP | -0.687 | -0.289* | 4.418 |
| | (0.987) | (0.165) | (4.883) |
| D_DEMOC | -0.071 | 0.004 | -0.240 |
| | (0.124) | (0.018) | (0.194) |
| | **Relation de long terme** | | |

| | | | |
|---|---|---|---|
| L2.lnDD | 0.367*** | 0.784*** | 0.617 |
| | (0.117) | (0.304) | (0.475) |
| L.lnPIB | 0.090*** | -0.057 | -0.075 |
| | (0.029) | (0.096) | (0.053) |
| L.lnENRGIE | 0.174*** | 0.380** | 0.533 |
| | (0.031) | (0.150) | (0.328) |
| L.lnPOP | 0.098** | 0.184** | 0.178 |
| | (0.042) | (0.094) | (0.131) |
| L.DEMOC | 1.542*** | 0.195 | -0.927 |
| | (0.258) | (0.201) | (0.765) |
| Constant | -0.072 | -0.206* | -3.764* |
| | (0.044) | (0.112) | (2.064) |
| Observations | 1,083 | 1,083 | 1,083 |
| Countries | 29 | 29 | 29 |

Ecart-types robustes entre parenthèses : *** p<0.01, ** p<0.05, * p<0.1

Source : Auteurs

Tableau 4. Effets du dividende démographique sur la qualité environnementale en Afrique.

| | (1) | (2) | (3) |
|---|---|---|---|
| VARIABLES | PMG | DFE | MG |
| **ec** | -0.028*** | -0.041*** | -0.146** |
| | (0.009) | (0.009) | (0.064) |
| **Relation de court terme** | | | |
| D_lnDDAJUSTE | 0.145* | -0.004 | 0.377 |
| | (0.081) | (0.035) | (0.260) |
| D_lnPIB | -0.004 | 0.002 | 0.003 |
| | (0.029) | (0.014) | (0.040) |
| D_lnENRGIE | -0.022 | 0.034** | -0.161 |
| | (0.057) | (0.016) | (0.200) |
| D_lnPOP | -1.418* | -0.160 | 30.437 |
| | (0.860) | (0.158) | (30.575) |
| D_DEMOC | -0.101 | 0.001 | -0.406 |
| | (0.135) | (0.018) | (0.282) |
| **Relation de long terme** | | | |
| D_lnDDAJUSTE | 0.495*** | 0.474* | -0.065 |
| | (0.075) | (0.287) | (0.284) |
| L.lnPIB | 0.216*** | -0.103 | -0.158 |
| | (0.031) | (0.103) | (0.135) |
| L.lnENRGIE | -0.097* | 0.308** | 0.911 |
| | (0.057) | (0.152) | (0.733) |
| L.lnPOP | 0.282*** | 0.125 | 0.289 |
| | (0.040) | (0.093) | (0.277) |
| L.DEMOC | 0.677*** | 0.124 | -0.448 |
| | (0.107) | (0.210) | (0.386) |
| Constant | -0.099* | -0.070 | -2.099 |

| | | | |
|---|---|---|---|
| | (0.056) | (0.095) | (3.043) |
| Observations | 1,083 | 1,083 | 1,083 |
| Countries | 29 | 29 | 29 |

Ecart-types robustes entre parenthèses : *** p<0.01, ** p<0.05, * p<0.1
Source : Auteurs

Tableau 5. Effets du dividende démographique sur la qualité environnementale en Afrique : Changement de la technique d'estimation.

| | (1) | (2) |
|---|---|---|
| VARIABLES | FE | RE |
| L.lnDD | 0.074** | 0.074** |
| | (0.032) | (0.032) |
| L.lnPIB | 0.001 | 0.001 |
| | (0.013) | (0.013) |
| L.lnENRGIE | 0.010 | 0.010 |
| | (0.017) | (0.017) |
| L.lnPOP | 0.127*** | 0.127*** |
| | (0.012) | (0.012) |
| L.DEMOC | 0.079*** | 0.079*** |
| | (0.027) | (0.027) |
| Constant | 1.018*** | 1.090*** |
| | (0.346) | (0.351) |
| Observations | 1,112 | 1,112 |
| R-squared | 0.207 | |
| Countries | 29 | 29 |
| Countries fixed effets | yes | no |

Ecart-types robustes entre parenthèses, *** p<0.01, ** p<0.05, * p<0.1
Source : Auteurs

Tableau 6. Test de Oster (2019) estimations liées.

| | (1) Effet contrôlé | (2) Ensemble identifié |
|---|---|---|
| | $\hat{\beta}$ (S.E) | $[\hat{\beta},\ \beta^*\ (Min\,\{1;\ 1{,}3\widehat{R^2}\}, \delta\ =\ 1)]$ |
| Panel : QUALENV | | |
| DD | 0.0739** (0.0324) | [0,0739 ; 158,701] |
| Observations | 1,112 | |
| R-Carrée | 0,207 | |

Note : Les résultats de la colonne (1) sont reproduits à partir du tableau 5. L'écart-type robuste est entre parenthèse. ** indique une significativité au seuil de 5 %.

Tableau 7. Effets du dividende démographique sur la qualité environnementale en Afrique : Correction d'endogénéité à l'aide de la méthode de 2SLS-Lewbel

| | Double moindres carrés (2SLS-Lewbel) | | | |
|---|---|---|---|---|
| | L.lnQUALENV | | | |
| VARIABLES | 1 | 2 | 3 | 4 |
| L.lnDD | 0.952*** | 0.452 | 0.694** | 0.543* |
| | (0.140) | (0.301) | (0.304) | (0.283) |
| L.lnPIB | 0.00865** | -0.000594 | -0.000425 | -0.00140 |
| | (0.00347) | (0.00840) | (0.00826) | (0.00768) |
| L.lnENRGIE | | -2.46e-05 | 2.15e-05 | 3.78e-05 |
| | | (8.88e-05) | (8.83e-05) | (8.21e-05) |
| L.lnPOP | | | -0.184*** | -0.127** |
| | | | (0.0579) | (0.0547) |
| L.DEMOC | | | | 0.601*** |
| | | | | (0.102) |
| Constant | -0.592 | 1.633 | 3.642** | 3.988*** |
| | (0.622) | (1.315) | (1.454) | (1.351) |
| Observations | 1,165 | 230 | 230 | 230 |
| R-carré | -0.042 | -0.001 | 0.032 | 0.164 |

Ecart-types robustes entre parenthèses, *** p<0.01, ** p<0.05, * p<0.1

Source : Auteurs

Tableau 8. Effets du dividende démographique sur la qualité environnementale en Afrique

| | Double moindres carrés (2SLS-Lewbel) | | | | | |
|---|---|---|---|---|---|---|
| | Qualité environnementale (Déforestation) | | | | | |
| VARIABLES | 1 | 2 | 3 | 4 | 5 | 6 |
| L.lnDD | 0.260 | 0.661* | 0.539** | 1.431*** | 1.611*** | 4.288*** |
| | (0.283) | (0.390) | (0.228) | (0.404) | (0.435) | (0.633) |
| L.lnPIB | -0.00224 | -0.00139 | -0.269*** | 0.0298* | 0.0305* | 0.0175 |
| | (0.00765) | (0.00767) | (0.0513) | (0.0152) | (0.0157) | (0.0194) |
| L.lnENRGIE | 2.84e-06 | -7.77e-05 | -0.0425 | 0.574*** | 0.689*** | 0.387** |
| | (8.18e-05) | (0.000216) | (0.0569) | (0.158) | (0.180) | (0.190) |
| L.lnPOP | -0.114** | -3.82e-09* | 0.0485** | -0.280*** | -0.283*** | 4.24e-10 |
| | (0.0544) | (1.99e-09) | (0.0213) | (0.0580) | (0.0716) | (3.36e-09) |
| L.DEMOC | 0.611*** | 0.592*** | 0.119*** | 0.548** | 0.477* | 0.820*** |
| | (0.102) | (0.114) | (0.0388) | (0.279) | (0.288) | (0.116) |
| L.lnPRATIQAGRIC | | -0.163 | -0.299*** | 0.0567*** | 0.0646*** | 0.0419 |
| | | (0.295) | (0.0589) | (0.0101) | (0.0110) | (0.0305) |
| L.lnUTILRESS | | | -0.154*** | -0.151*** | -0.170*** | -0.387*** |
| | | | (0.0138) | (0.0460) | (0.0498) | (0.0457) |
| L.lnURBANIS | | | | 0.0585*** | 0.0615*** | 0.106*** |
| | | | | (0.00737) | (0.00746) | (0.0102) |
| L.lnOUVCOM | | | | | 0.133 | 0.768** |
| | | | | | (0.272) | (0.326) |
| L.lnIDE | | | | | | 3.930*** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | (1.332) |
| Constant | 5.011*** | 1.981 | 3.832*** | -5.220** | -6.975** | -34.63*** |
| | (1.349) | (1.273) | (1.282) | (2.585) | (3.269) | (5.585) |
| Observations | 230 | 231 | 1,012 | 186 | 183 | 136 |
| R-squared | 0.171 | 0.157 | 0.156 | 0.376 | 0.395 | 0.588 |

Ecart-types robustes entre parenthèses : *** p<0.01, ** p<0.05, * p<0.1

Source : Auteurs

Tableau 9. Effets du dividende démographique sur la qualité environnementale en Afrique : Canaux potentiels

| | Double moindres carrés (2SLS-Lewbel) | | | | | |
|---|---|---|---|---|---|---|
| | Qualité environnementale (Déforestation) | | | | | |
| VARIABLES | 1 | 2 | 3 | 4 | 5 | 6 |
| L.lnDD | 0.260 | 1.160** | 0.498** | 4.493*** | 0.967*** | 3.104*** |
| | (0.283) | (0.580) | (0.229) | (0.647) | (0.313) | (0.699) |
| L.lnPIB | -0.00224 | 0.0272 | -0.00175 | 0.0204* | 0.0324** | 0.0187 |
| | (0.00765) | (0.0240) | (0.00360) | (0.0120) | (0.0162) | (0.0122) |
| L.lnENRGIE | 2.84e-06 | -0.406* | -0.196*** | 0.000692*** | 0.000948*** | 0.000624*** |
| | (8.18e-05) | (0.210) | (0.0494) | (0.000129) | (0.000143) | (0.000116) |
| L.lnPOP | -0.114** | -0.157** | 0.0377* | -2.65e-08*** | -0.384*** | -2.88e-08*** |
| | (0.0544) | (0.0740) | (0.0195) | (2.15e-09) | (0.0755) | (2.10e-09) |
| L.DEMOC | 0.611*** | 0.434*** | 0.0562 | 0.338*** | -0.217* | 0.346 |
| | (0.102) | (0.152) | (0.0388) | (0.0982) | (0.128) | (0.238) |
| L. lnDD*lnPRATIQAGRIC | | -0.177*** | -0.049*** | 0.129*** | 0.014*** | 0.009*** |
| | | (0.065) | (0.014) | (0.020) | (0.002) | (0.001) |
| L.lnDD*lnUTILRESS | | | -0.00635*** | -1.767*** | -0.00738*** | -1.310*** |
| | | | (0.000487) | (0.225) | (0.00170) | (0.234) |
| L.lnDD*lnURBANIS | | | | 0.0454*** | 0.0106*** | 0.0344*** |
| | | | | (0.00544) | (0.00140) | (0.00560) |
| L.lnDD*lnOUVCOM | | | | | 0.213*** | -0.0840** |
| | | | | | (0.0768) | (0.0407) |
| L.lnDD*lnIDE | | | | | | 0.116* |
| | | | | | | (0.0623) |
| Constant | 5.011*** | 6.135*** | 2.940*** | 3.230*** | 1.568 | 3.012*** |
| | (1.349) | (2.181) | (1.056) | (0.765) | (1.807) | (0.730) |
| Observations | 230 | 141 | 1,016 | 186 | 159 | 159 |
| R-squared | 0.171 | 0.206 | 0.184 | 0.666 | 0.481 | 0.723 |

Ecart-types robustes entre parenthèses : *** p<0.01, ** p<0.05, * p<0.1

Source : Auteurs

Tableau 10. Effets du dividende démographique sur la qualité environnementale en Afrique : Effets régions.

| | Double moindres carrés (2SLS-Lewbel) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Qualité environnementale (Déforestation) | | | | | | | | | | | | | | | | | |
| VARIABLES | Afrique du nord | | | | | | Afrique centrale | | | | | | Afrique de l'ouest | | | | | |
| L.lnDD | 1,702*** | 0,023 | 2,570*** | 5,967*** | 6,480*** | 4,508*** | 2,759*** | 2,783*** | 2,287*** | 2,485*** | 3,391*** | 5,241*** | -2,177*** | -2,085*** | -1,065*** | -0,808* | 0,040 | -0,900** |
| | (0,578) | (1,032) | (0,819) | (1,284) | (1,900) | (1,449) | (1,049) | (0,709) | (0,483) | (0,696) | (0,604) | (0,993) | (0,247) | (0,239) | (0,327) | (0,474) | (0,382) | (0,408) |
| L.lnPIB | 0,018 | 0,881 | 0,049*** | 0,045** | 0,046* | 0,022 | 0,036*** | -0,009 | -0,000 | -0,016** | -0,021*** | 0,000 | 0,122*** | 0,078* | 0,183*** | 0,151* | 0,001 | -0,001 |
| | (0,025) | (0,650) | (0,019) | (0,022) | (0,024) | (0,022) | (0,009) | (0,009) | (0,007) | (0,007) | (0,007) | (0,011) | (0,044) | (0,045) | (0,049) | (0,078) | (0,004) | (0,004) |
| L.lnENRGIE | -0,001*** | -2,346*** | -0,001* | 8,78e-05 | 0,000 | 0,000 | -0,002*** | -0,002*** | -0,002*** | -0,002*** | -0,002*** | -1,340*** | -0,046 | -0,075 | -0,064 | -0,104 | -0,350*** | -0,001*** |
| | (0,000) | (0,532) | (0,000) | (0,001) | (0,001) | (0,000) | (0,000) | (0,000) | (8,49e-05) | (0,000) | (0,000) | (0,139) | (0,063) | (0,062) | (0,059) | (0,099) | (0,073) | (0,000) |
| L.lnPOP | -1,573*** | -1,406*** | -0,916*** | 1,159*** | 1,206** | 1,298*** | -0,271*** | -0,098** | -7,26e-09*** | 0,003 | 0,006 | -0,009 | 2,03e-09*** | 2,69e-09*** | 6,11e-10 | 8,21e-10 | 4,74e-09*** | 5,92e-09*** |
| | (0,121) | (0,105) | (0,079) | (0,324) | (0,549) | (0,437) | (0,056) | (0,039) | (1,77e-09) | (0,036) | (0,035) | (0,044) | (4,70e-10) | (5,05e-10) | (6,70e-10) | (8,22e-10) | (6,44e-10) | (8,40e-10) |
| L.DEMOC | 1,784** | 0,689*** | 0,260 | -0,452** | -0,762 | -0,468** | -0,552*** | -0,740* | -0,242*** | -0,450*** | -1,313*** | -0,127 | -0,523*** | -0,477*** | -0,397*** | -0,421*** | -1,322*** | -1,096*** |
| | (0,777) | (0,206) | (0,276) | (0,211) | (0,562) | (0,185) | (0,105) | (0,403) | (0,089) | (0,085) | (0,331) | (0,147) | (0,065) | (0,064) | (0,064) | (0,082) | (0,166) | (0,130) |
| L.lnPRATIQAGRIC | | 0,014 | -0,238*** | -0,169*** | -0,172*** | -0,099* | | -0,695*** | -0,708*** | -0,677*** | -0,601*** | -1,118*** | | -0,007*** | -0,013*** | -0,013*** | -0,011*** | -0,010*** |
| | | (0,016) | (0,025) | (0,052) | (0,058) | (0,058) | | (0,076) | (0,084) | (0,113) | (0,123) | (0,179) | | (0,002) | (0,003) | (0,003) | (0,003) | (0,003) |
| L.lnUTILRESS | | | -0,056*** | -0,122*** | -0,128*** | -0,107*** | | | -0,005* | -0,009*** | -0,005* | -0,242*** | | | 0,023*** | 0,025*** | 0,014** | 0,010 |
| | | | (0,010) | (0,019) | (0,027) | (0,022) | | | (0,003) | (0,002) | (0,003) | (0,079) | | | (0,005) | (0,006) | (0,006) | (0,005) |
| L.lnURBANIS | | | | 13,49*** | 13,39*** | 12,71*** | | | | 0,997** | 1,567*** | 1,321** | | | | 0,129 | 0,019*** | 0,008** |
| | | | | (1,843) | (2,437) | (1,860) | | | | (0,475) | (0,457) | (0,530) | | | | (0,234) | (0,005) | (0,003) |
| L.lnOUVCOM | | | | | 0,524 | 0,989 | | | | | -0,105 | -0,154 | | | | | 0,423*** | 0,372*** |
| | | | | | (0,896) | (0,855) | | | | | (0,149) | (0,206) | | | | | (0,080) | (0,077) |
| L.lnIDE | | | | | | 1,301 | | | | | | 0,011 | | | | | | 0,362* |
| | | | | | | (1,285) | | | | | | (0,028) | | | | | | (0,216) |
| Constant | 23,68*** | 36,39*** | 12,31*** | -92,78*** | -94,90*** | -92,20*** | -5,101 | -5,199* | -4,840** | -9,978** | -15,51*** | -13,63** | 12,69*** | 12,92*** | 7,636*** | 6,432*** | 6,019*** | 7,521*** |
| | (2,580) | (4,399) | (3,732) | (16,81) | (26,23) | (20,34) | (4,198) | (2,881) | (2,096) | (4,971) | (4,463) | (5,592) | (1,309) | (1,264) | (1,709) | (2,298) | (1,773) | (2,157) |
| Observations | 91 | 80 | 137 | 83 | 83 | 65 | 65 | 59 | 59 | 59 | 56 | 41 | 135 | 135 | 135 | 135 | 135 | 171 |
| R-squared | 0,663 | 0,847 | 0,795 | 0,856 | 0,844 | 0,890 | 0,608 | 0,839 | 0,912 | 0,904 | 0,908 | 0,852 | 0,718 | 0,737 | 0,763 | 0,758 | 0,824 | 0,718 |

Ecart-types robustes entre parenthèses : *** p<0.01, ** p<0.05, * p<0.1

Source : Auteurs

Tableau 11. Effets du dividende démographique sur la qualité environnementale en Afrique : Effets régions (Suite)

| | Double moindres carrés (2SLS-Lewbel) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Qualité environnementale (Déforestation) | | | | | | | | | | | |
| VARIABLES | Afrique australe | | | | | | Afrique de l'Est | | | | | |
| L.lnDD | 0.190** | 0.163* | 0.314*** | 0.463*** | 0.369** | 0.248* | 0.750*** | 0.751*** | 0.689*** | 1.258*** | 0.677*** | 0.640*** |
| | (0.0923) | (0.0949) | (0.0951) | (0.112) | (0.156) | (0.149) | (0.177) | (0.167) | (0.116) | (0.131) | (0.115) | (0.117) |
| L.lnPIB | 0.438*** | 0.439*** | 0.404*** | 0.422*** | 0.441*** | 0.668*** | 0.0881*** | 0.0378 | 0.00680*** | 0.0626** | 0.00579*** | 0.00626*** |
| | (0.0331) | (0.0329) | (0.0494) | (0.0489) | (0.0970) | (0.0657) | (0.0206) | (0.0245) | (0.00196) | (0.0251) | (0.00182) | (0.00188) |
| L.lnENRGIE | -0.189*** | -0.139** | -0.270*** | -0.422*** | -0.140 | -0.00628 | -0.200** | -0.0842 | -0.0863 | 0.115* | -0.109 | -0.136* |
| | (0.0525) | (0.0663) | (0.0457) | (0.0839) | (0.123) | (0.105) | (0.0825) | (0.0831) | (0.0662) | (0.0674) | (0.0698) | (0.0714) |
| L.lnPOP | 1.52e-08*** | 1.43e-08*** | 1.80e-08*** | 2.12e-08*** | 0.245*** | 0.245*** | -0.177*** | -0.146*** | -0.0982*** | -0.106*** | -0.0326** | -0.0308* |
| | (1.38e-09) | (1.57e-09) | (1.23e-09) | (1.90e-09) | (0.0404) | (0.0337) | (0.0188) | (0.0201) | (0.0147) | (0.0141) | (0.0163) | (0.0168) |
| L.DEMOC | -0.116*** | -0.0967*** | -0.0710*** | -0.0911*** | 0.413*** | -0.0656 | 0.0264 | -0.0165 | -0.0541*** | -0.0710*** | -0.110*** | -0.107*** |
| | (0.0259) | (0.0300) | (0.0274) | (0.0289) | (0.151) | (0.0592) | (0.0261) | (0.0280) | (0.0192) | (0.0210) | (0.0184) | (0.0185) |
| L.lnPRATIQAGRIC | | 0.0338 | -0.00812*** | -0.00914*** | -0.0877*** | -0.0198*** | | -0.00696*** | -0.0138*** | -0.0102*** | -0.0102*** | -0.00974*** |
| | | (0.0278) | (0.00262) | (0.00262) | (0.0303) | (0.00280) | | (0.00191) | (0.00196) | (0.00190) | (0.00200) | (0.00208) |
| L.lnUTILRESS | | | -0.0106*** | -0.0112*** | -0.0786*** | -0.0210*** | | | -0.00743*** | -0.00575** | -0.0125*** | -0.0136*** |
| | | | (0.00301) | (0.00299) | (0.0135) | (0.00317) | | | (0.00210) | (0.00256) | (0.00287) | (0.00307) |
| L.lnURBANIS | | | | 0.189** | -0.228 | -0.0155*** | | | | 0.0103*** | 0.00474** | 0.00441** |
| | | | | (0.0911) | (0.148) | (0.00269) | | | | (0.00220) | (0.00185) | (0.00206) |
| L.lnOUVCOM | | | | | 0.125* | 0.287*** | | | | | 0.00300*** | 0.00305*** |
| | | | | | (0.0712) | (0.0517) | | | | | (0.000457) | (0.000460) |
| L.lnIDE | | | | | | -2.98e-05 | | | | | | 0.00222 |
| | | | | | | (0.00271) | | | | | | (0.00365) |
| Constant | 0.562 | 0.287 | 0.955 | 0.453 | -3.245** | -6.654*** | 4.101*** | 3.334*** | 3.241*** | -1.164 | 1.924** | 2.223*** |
| | (0.556) | (0.595) | (0.656) | (0.670) | (1.403) | (1.254) | (1.033) | (0.981) | (0.745) | (0.917) | (0.797) | (0.824) |
| Observations | 126 | 126 | 66 | 66 | 58 | 64 | 145 | 143 | 123 | 123 | 111 | 109 |
| R-squared | 0.928 | 0.929 | 0.970 | 0.971 | 0.970 | 0.979 | 0.714 | 0.746 | 0.884 | 0.894 | 0.894 | 0.891 |

Ecart-types robustes entre parenthèses : *** p<0.01, ** p<0.05, * p<0.1

Source : Auteurs

Annexes

| | Test de racine unitaire de Madala and Wu (1999) | | | | | | Test de racine unitaire de Pesaran (2007) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Variables en niveau | | | | | | | | | | | |
| | Specification sans trend | | | Specification avec trend | | | Specififcation sans trend | | | Specification avec trend | | |
| Variable | lags | chi_sq | p-value | lags | chi_sq | p-value | lags | Zt-bar | p-value | lags | Zt-bar | p-value |
| lnAgriland | 0 | 59.971 | 0.404 | 0 | 95.579 | 0.001 | 0 | 3.563 | 1.000 | 0 | 2.665 | 0.996 |
| lnAgriland | 1 | 52.153 | 0.691 | 1 | 82.772 | 0.018 | 1 | 1.763 | 0.961 | 1 | 0.565 | 0.714 |
| lnAgriland | 2 | 41.462 | 0.950 | 2 | 77.821 | 0.042 | 2 | 1.685 | 0.954 | 2 | 2.275 | 0.989 |
| Ratio_dep | 0 | 61.010 | 0.368 | 0 | 114.658 | 0.000 | 0 | 1.397 | 0.919 | 0 | 4.534 | 1.000 |
| Ratio_dep | 1 | 548.551 | 0.000 | 1 | 587.169 | 0.000 | 1 | -7.468 | 0.000 | 1 | -5.612 | 0.000 |
| Ratio_dep | 2 | 70.890 | 0.119 | 2 | 89.025 | 0.005 | 2 | 2.016 | 0.978 | 2 | 5.789 | 1.000 |
| lnGDP | 0 | 55.960 | 0.552 | 0 | 62.104 | 0.332 | 0 | -0.103 | 0.459 | 0 | 0.734 | 0.769 |
| lnGDP | 1 | 57.980 | 0.476 | 1 | 85.517 | 0.011 | 1 | 0.602 | 0.726 | 1 | 0.354 | 0.638 |
| lnGDP | 2 | 54.771 | 0.596 | 2 | 98.604 | 0.001 | 2 | 0.555 | 0.710 | 2 | 0.543 | 0.706 |
| lnNGIE | 0 | 64.197 | 0.268 | 0 | 52.940 | 0.663 | 0 | 0.994 | 0.840 | 0 | 1.681 | 0.954 |
| lnNGIE | 1 | 61.791 | 0.342 | 1 | 51.254 | 0.722 | 1 | 0.482 | 0.685 | 1 | 1.007 | 0.843 |
| lnNGIE | 2 | 59.089 | 0.436 | 2 | 43.103 | 0.928 | 2 | 1.263 | 0.897 | 2 | 1.883 | 0.970 |
| lnPOP | 0 | 893.416 | 0.000 | 0 | 78.750 | 0.036 | 0 | -0.451 | 0.326 | 0 | 10.315 | 1.000 |
| lnPOP | 1 | 146.347 | 0.000 | 1 | 856.356 | 0.000 | 1 | -2.071 | 0.019 | 1 | -11.805 | 0.000 |
| lnPOP | 2 | 229.644 | 0.000 | 2 | 66.533 | 0.207 | 2 | 1.982 | 0.976 | 2 | 6.585 | 1.000 |
| v2x_polyar~y | 0 | 85.724 | 0.010 | 0 | 72.327 | 0.098 | 0 | -2.447 | 0.007 | 0 | -0.299 | 0.382 |
| v2x_polyar~y | 1 | 123.454 | 0.000 | 1 | 129.159 | 0.000 | 1 | -2.760 | 0.003 | 1 | -0.031 | 0.488 |
| v2x_polyar~y | 2 | 169.239 | 0.000 | 2 | 157.690 | 0.000 | 2 | -1.024 | 0.153 | 2 | 0.998 | 0.841 |

Source : Auteurs

Liste des Pays

| | | |
|---|---|---|
| Algeria | Ethiopia | Niger |
| Angola | Gabon | Nigeria |
| Benin | Ghana | Rwanda |
| Botswana | Guinea | Senegal |
| Burkina Faso | Kenya | Sierra Leone |
| Burundi | Liberia | Somalia |
| Cameroon | Libya | South Africa |
| Central African Republic | Madagascar | Sudan |
| Chad | Malawi | Tanzania |
| Congo, Dem, Rep, | Mali | Togo |
| Congo, Rep, | Mauritania | Tunisia |
| Cote d'Ivoire | Mauritius | Uganda |
| Djibouti | Morocco | Zambia |
| Egypt, Arab Rep, | Mozambique | Zimbabwe |
| Eritrea | Namibia | |

Source : Auteurs

| | Test de racine unitaire madala and wu (1999) | | | | | | Test de racine unitaire de Pesaran (2007) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Variables en différence première | | | | | | Variable en différence première | | | | | |
| | Specification sans trend | | | Specification avec trend | | | Specification sana trend | | | Specification avec trend | | |
| Variable | lags | chi_sq | p-value | lags | chi_sq | p-value | lags | Zt-bar | p-value | lags | Zt-bar | p-value |
| D_lnAgriland | 0 | 724.295 | 0.000 | 0 | 637.730 | 0.000 | 0 | -15.434 | 0.000 | 0 | -14.370 | 0.000 |
| D_lnAgriland | 1 | 354.397 | 0.000 | 1 | 293.784 | 0.000 | 1 | -8.816 | 0.000 | 1 | -7.404 | 0.000 |
| D_lnAgriland | 2 | 205.472 | 0.000 | 2 | 156.966 | 0.000 | 2 | -4.108 | 0.000 | 2 | -1.912 | 0.028 |
| D_Ratio_dep | 0 | 65.246 | 0.239 | 0 | 40.075 | 0.965 | 0 | 0.891 | 0.814 | 0 | 0.587 | 0.722 |
| D_Ratio_dep | 1 | 183.798 | 0.000 | 1 | 169.291 | 0.000 | 1 | -5.144 | 0.000 | 1 | -5.063 | 0.000 |
| D_Ratio_dep | 2 | 84.788 | 0.012 | 2 | 47.874 | 0.826 | 2 | 0.221 | 0.587 | 2 | 0.845 | 0.801 |
| D_lnGDP | 0 | 705.398 | 0.000 | 0 | 642.762 | 0.000 | 0 | -16.962 | 0.000 | 0 | -15.869 | 0.000 |
| D_lnGDP | 1 | 363.787 | 0.000 | 1 | 329.476 | 0.000 | 1 | -10.529 | 0.000 | 1 | -9.942 | 0.000 |
| D_lnGDP | 2 | 243.743 | 0.000 | 2 | 217.725 | 0.000 | 2 | -5.102 | 0.000 | 2 | -4.797 | 0.000 |
| D_lnNGIE | 0 | 890.960 | 0.000 | 0 | 816.941 | 0.000 | 0 | -20.161 | 0.000 | 0 | -19.500 | 0.000 |
| D_lnNGIE | 1 | 442.026 | 0.000 | 1 | 407.928 | 0.000 | 1 | -12.478 | 0.000 | 1 | -11.554 | 0.000 |
| D_lnNGIE | 2 | 234.693 | 0.000 | 2 | 215.258 | 0.000 | 2 | -7.549 | 0.000 | 2 | -6.785 | 0.000 |
| D_lnPOP | 0 | 62.640 | 0.315 | 0 | 40.596 | 0.960 | 0 | 3.622 | 1.000 | 0 | 5.801 | 1.000 |
| D_lnPOP | 1 | 544.446 | 0.000 | 1 | 742.293 | 0.000 | 1 | -14.405 | 0.000 | 1 | -14.115 | 0.000 |
| D_lnPOP | 2 | 57.421 | 0.497 | 2 | 42.602 | 0.935 | 2 | 0.505 | 0.693 | 2 | 0.033 | 0.513 |
| D_v2x_poly~y | 0 | 692.284 | 0.000 | 0 | 578.479 | 0.000 | 0 | -18.392 | 0.000 | 0 | -16.286 | 0.000 |
| D_v2x_poly~y | 1 | 499.176 | 0.000 | 1 | 405.955 | 0.000 | 1 | -13.012 | 0.000 | 1 | -11.562 | 0.000 |
| D_v2x_poly~y | 2 | 428.187 | 0.000 | 2 | 235.425 | 0.000 | 2 | -8.094 | 0.000 | 2 | -6.146 | 0.000 |

Source : Auteurs

Test de Multicolinéarité

| Variable | VIF | 1/VIF |
|---|---|---|
| DD | 2.36 | 0.424166 |
| PIB | 4.31 | 0.232058 |
| ENRGIE | 2.93 | 0.340921 |
| POP | 2.19 | 0.455979 |
| DEMOC | 1.33 | 0.750595 |
| PRATIQAGRIC | 2.72 | 0.367268 |
| UTILRESS | 2.08 | 0.480732 |
| URBANIS | 3.31 | 0.302173 |
| OUVCOM | 3.32 | 0.301540 |
| IDE | 1.18 | 0.84[illegible] |
| Moyenne VIF | 2.57 | |

| Test de Hausman |
|---|
| Test de H0 : la différence de coefficients n'est pas systématique |
| chi2(5) = (b-B)'[(V_bV_B)^(-1)](b-B) |
| = 6.26 |
| Prob > chi2 = 0.2815 |