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Article

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Demographic structure, structural change, and economic growth: panel evidence in sub-Saharan African countries

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ABSTRACT

In the face of rapid demographic transitions, Sub-Saharan African countries stand at a critical juncture where the potential for harnessing a demographic dividend to fuel economic growth is immense. This demographic shift presents both challenges and opportunities, with the right investments in health, education, and employment, countries can turn the growing youth population into a powerful engine for development, driving substantial and sustainable economic progress across the region. This study examines the demographic structure effect on economic growth in the context of structural changes in 26 sub-Saharan African countries. Using data from 1992 to 2019 in the PMG-ARDL, FMOLS, and DOLS estimates, we find that demographic structure has a positive influence on economic growth in the long run, which occurs through effective structural change, that is, structural changes that occur with an increase in labor productivity growth. Indeed, our results show that structural changes are relevant in transforming African youth debt into demographic dividends.

IMPACT STATEMENT

The study investigates the impact of demographic structure on economic growth within the context of structural changes in 26 sub-Saharan African countries from 1992 to 2019. It provides a detailed analysis of the impact of demographic transition, characterized by declining fertility rates and an expanding working-age population, on economic growth in sub-Saharan Africa. It highlights the importance of structural changes, such as labor productivity and sectoral composition variations, to transform demographic advantages into sustainable economic growth. Using robust econometric methods (PMG-ARDL, FMOLS, and DOLS), the research demonstrates a significant positive long-term impact of demographic structure on economic development, mediated by effective structural change. The policy implications include promoting family planning and education for young girls, which will help reduce dependency ratios, accelerate demographic transitions, and encourage industrialization and innovation to drive structural change and improve labor productivity. Incorporating demographic characteristics such as education levels and health status into economic planning will help maximize the benefits of demographic transitions. Recommendations include encouraging demographic and sectoral policies to effectively manage demographic transitions and promote structural change and innovation. Future research should include country-specific analyses to address heterogeneity and incorporate additional indicators such as education and health to capture their nuanced impacts on economic growth. The results of this study are significant for policymakers, researchers, and development practitioners working in sub-Saharan Africa. By providing empirical evidence on the interaction between demographic structure and structural change, the study offers valuable insights into strategies for leveraging the demographic dividend to fuel sustainable economic growth in the region. This research contributes to a better understanding of how to navigate demographic transitions and structural changes to achieve long-term economic development.

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1. Introduction

In sub-Saharan African (SSA) countries, the demographic transition is undergoing, with the total fertility rate (TFR) falling from 7 to 5.7 births per woman from 1980 to 2017. Demographic structure in Sub-Saharan Africa is characterized by a young, active population, World Bank statistics in 2022 showed that 24.74% of the population is under 15 and 55.18% of working age. According to estimates for 2022 by the United Nations World Population Prospect, the population of this region is likely to double by 2050. African policymakers have foreknowledge of the potential of having a large working-age population for economic growth. Indeed, with the economic convergence of Asia towards the developed countries over the last few decades, most studies have presented the demographic structure as the main factor in this economic growth (Bloom et al., 2003; Bloom & Williamson, 1998). For researchers, the studies of the channels through which demographic structures affect economic growth have raised interest. Bloom and Williamson (1998) found that the economic miracle of emerging Asia stems from the large working-age population on economic growth through human capital and savings. According to Urdal (2006), the rise of the 'youth bulges' is associated with an increased risk of political violence and government expenditures which could in turn affect economic growth. For Mason et al. (2016), the positive effect of the demographic structure on economic growth is produced through, first, in the short term, the support ratio¹, which is the productivity gain coming from the large effective (productive) employed population to the effective (non-productive) dependent population; second, in the long term, through labor force productivity created by human capital and saving.

However, although some studies present demographic structure as the main factor in economic convergence, some have revealed the importance of the economic structure as an essential channel in meeting the employment demand of the working-age population. Wei and Hao (2010) have found that the positive effect of the effect of age structure on economic growth in China is more pronounced in provinces that are more open to market forces. In other words, the provinces that have undergone effective structural change have experienced greater economic growth thanks to their capacity to absorb the working-age population. Structural change could prove to be a channel through which demographic structure influences economic growth. Indeed, the demographic structure could influence economic growth through structural changes at two levels. On the demand side, the demographic structure will change the demand structure, particularly within household consumption, including the introduction of non-homothetic preferences or 'hierarchy of needs' in consumption, which reflects or means a structural change according to Kuznets (1973). This thesis is supported by Stijepic and Wagner (2012), who argue that a change in the demographic structure leads to a change in age-specific consumption demand. Thus, the production adjustment to this new consumption demand under general equilibrium occurs through structural changes. On the supply side, consider Pasinetti's (1981) conception of structural change, which is innovation (technical progress). Innovation cannot emerge insofar as the demographic structure defines the horizon of needs. Consequently, any effect of demographic structure on economic growth can be achieved through innovation, that is, structural change. These two processes could occur at two different times. The effect on demand with the demographic structure could occur in the short term, and on the supply side, innovation appears in the long term.

Furthermore, Wongboonsin and Phiromswad (2017) having examined an extensive collection of channels through which demographic structure affects economic growth, such as government revenues and expenditures, institutions, trade, human capital, inflation, and trade; failed to identify structural change as an important channel.

In the structural change context, the study of the impact of demographic structure on economic growth is an open issue. This issue is more important in economies of sub-Saharan Africa, where structural change is not yet effective. Indeed, most of the labor force in this region is concentrated in the less productive agricultural sector (Calderon, 2021). It is therefore worth studying how the structural change in sub-Saharan countries might affect the effect of demographic structure on economic growth.

In this regard, this study aims to address the following two questions: First, we show here a short- and long-term relationship between the demographic structure on economic growth in SSA, in contrast to most of the studies focusing on the problem of endogeneity by using the instrumental variable (IV)

method or Generalized Method of Moments (GMM) panel. Second, after incorporating structural change, what is the impact of demographic structure on economic growth?

The main contributions of this study are as follows: First, this study incorporates structural change as a channel through which demographic structure affects economic growth. Second, this study employs the effective structural change indicator (ESC) developed by Vu (2017), which takes only sectors with a positive contribution to labor productivity growth – as a proxy variable for structural change in developing countries context.

The rest of the study is organized as follows: Section 2 presents the existing empirical literature review. Section 3 describes the methods and materials used for the empirical analysis. Section 4 presents the empirical results and a discussion. Section 5 concludes.

2. Literature review

The economic miracle in emerging Asia countries has triggered a large number of studies on the determinants of this miracle. Most of the studies considered the shape of age structure as the main factor, they found a positive impact of the demographic structure on economic growth. Other studies also found that structural change impacts economic growth by the absorption into employment of this large working-age population (Wei & Hao, 2010). To comprehend the impact of demographic structure, and structural change on economic growth, this paper divides the literature review into two parts: (1) channels through demographic structure affect economic growth; (2) structural change and economic growth.

2.1. Channels through which demographic structure affects economic growth

The relationship between demographic structure and economic growth is a multifaceted subject that has garnered significant attention in economic research. Scholars have explored various channels through which demographic changes impact economic performance, offering insights that are critical for policy formulation and economic planning. This review synthesizes findings from seminal studies, highlighting the mechanisms at play and the differing impacts across contexts.

Wei and Hao (2010) have provided foundational insights into how demographic structure benefits economic growth, primarily through its influence on steady-state income levels. They argue that the positive effects of demographic structure on income are more pronounced in provinces with greater market openness, emphasizing the role of age structure in economic dynamics.

Building on this premise, research by Bloom and Williamson (1998), and subsequently Bloom et al. (2003), delves into the mechanisms through which demographic change fosters economic growth. They identify three main channels: the labor force, savings, and human capital. The increase in the support rate, or the ratio of effective workers to consumers, plays a pivotal role, representing the first demographic dividend. The second dividend emerges through enhancements in savings and human capital, which interact over the long term to sustain economic growth.

Further exploration by Mason et al. (2016), along with Cruz and Ahmed (2018), reinforces the concept of demographic dividends. They differentiate between the immediate impact of labor force changes and the long-term benefits of savings and human capital accumulation.

In a study focusing on Brazil, Baerlocher et al. (2019) find that the demographic dividend, particularly age structure, primarily has accounting effects after adjusting for human capital variables. They argue that the educational component of the second demographic dividend is crucial for economic growth, overshadowing the first dividend.

Comparative analysis by Wongboonsin and Phiromswad (2017) highlights how the impact of demographic structure on economic growth varies between developed and developing countries. In developed nations, the presence of middle-aged workers positively influences growth through institutional development, investment, and education. Conversely, in developing countries, an increase in the proportion of young workers tends to hinder economic growth due to challenges in investment, financial market development, and trade.

Recent studies, such as Han and Lee (2020), emphasize the evolving nature of labor composition, including age, gender, education, and wage rates, in driving economic growth. Focusing on Korea, they demonstrate how the educational advancement of baby boom cohorts has propelled economic growth, a trend expected to continue as educational attainment levels rise.

Bairoliya and Miller (2021) employed an overlapping generations model to examine the effects of demographic changes on human capital accumulation and aggregate output. Their research underscores China's economic ascension from 1970 to 2010 as a product of strategic human capital investment policies, suggesting that educational spending can mitigate potential declines in per capita output.

2.2. Structural change and economic growth

The relationship between structural change and economic growth in the literature is controversial. However, most studies find a positive effect of structural change on economic growth.

One of the foundations of studies of structural change on economic growth comes from Arthur Lewis and his bi-sectoral growth model. Lewis (1954) presented a two-sector growth model in which economic growth is driven by the handover of surplus labor from the subsistence sector (agricultural sector) to the modern (industrial) sector. Chenery (1986) adds to the Lewis model, which also mentions that labor movement from the agricultural sector to the industry is the main driver of growth, savings and persistent investment are needed, and capital accumulation must be accompanied by structural transformation. Simon Kuznets and Luigi Pasinetti, despite their different approaches to empirical studies of structural transformation on economic growth, are seen as pioneers of structural transformation studies (Gabardo et al., 2017; Syrquin, 2010). The main differences are the main determinants of supply and demand, which lead to growth. On the demand side, the introduction of non-homothetic preferences by proposing Stone-Geary's preferences, or a 'hierarchy of needs' in consumption. On the supply side, the main innovation allowed for differential growth in productivity. Kuznets (1973) presented evidence of an exceptionally high rate of output growth and similar changes in the allocation of resources common to all developing countries. He concluded that this similarity was largely due to the replacement of the technology. pre-modern by modern technology across the entire industrial spectrum of the poverty-producing economy: agriculture, industry, transportation, and distribution. This indicates a high structural transformation in these sectors. Pasinetti (1981) explains that the imbalance between the limit of increasing production performance and saturated demand can be solved by the emergence of new production sectors.

Using the capital-labor ratio in agriculture as a structural change indicator, Dempster and Isaacs (2014) have shown that one of the sources of US growth after the civil war US is the structural movement of labor from southern to northern manufacturing. Dietrich (2012), with its Absolute Value Norm (NAV) as a structural change index, argues that structural change supports aggregate economic growth in OCED countries, irrespective of which measure of structural change is chosen. Vu (2017) created an effective structural change (ESC) index and GMM estimation in a developed country and found that effective structural change has a strong impact on GDP per capita growth in Asia's economies. Erumban et al. (2019) analyzed the role of structural change in determining India's aggregate productivity growth during 1980–2011. They showed that structural changes as workers moved to sectors with relatively higher labor productivity levels had a positive effect on economic growth and improved aggregate labor productivity growth. Piras (2022) investigated the role of structural changes in economic growth and convergence in Italy. Using fixed-effect regressions and GMM estimations, he found that the standard capital deepening mechanism was not the one that worked for convergence; rather, it was a structural change.

Some studies have found a negative relationship between structural change and economic growth. McMillan (2011) decomposed the change in aggregate productivity and showed that since 1990, structural change has hurt economic growth in Africa and Latin America. Diao et al. (2017) show that worker reallocation to services in African economies initially led to productivity enhancement, but eventually led to a decline in productivity.

Literature review showed that demographic structure impacts economic growth through various channels including labor market dynamics, savings rates, human capital development, and institutional frameworks. Based on the theoretical framework of the demographic dividend proposed by Bloom and

Williamson (1998), demographic structure affects structural change through three main channels, the labor force, savings, and human capital. However, this theoretical framework prevails, presupposing an effective structural change in the countries, which implies a direct effect on the demographic structure. Indeed, a country that has labor-intensive sectors and low overall productivity will not be able to respond to the new demand for new age-specific consumption generated by the change in demographic structure (Stijepic & Wagner, 2012). The effect of the demographic structure on economic growth is thus reduced because the labor force is not fully utilized, and the savings created will not be sufficient. So, it is imperative to consider structural change as an important transmission channel in this relationship. Therefore, first, this study fills the gap in the research. Indeed, considering the close relationship between demographic structure, structural change, and economic growth, it is necessary to analyze the three in the unified framework. Second, it is more interesting to use ESC as an indicator of structural change in Sub-Saharan African countries, because ESC measures structural change by any movement of labor between sectors that generates an increase in overall sector productivity and an increase in labor productivity.

3. Empirical analysis

3.1. Data

Our study used a balanced panel for 26 countries in Sub-Saharan Africa countries from 1992 to 2019. The study period and the 26 countries ($N = 26$) are chosen based on data availability. All the data were obtained from the World Development Indicator database. The use of these balanced data will enable us to reduce potential biases, have better control over unobserved heterogeneity that is constant over time, and increase the statistical power of our estimator. The Appendix presents the list of countries used in this study. The measure of economic growth is growth in real GDP per capita. We capture demographic structure using the demographic dependence ratio (DR). The dependency ratio (DR) is most commonly used to measure the demographic structure (Zhang et al., 2015). This categorization of the population into three age groups allows for the possibility that different age groups have different effects on economic growth.

Following the literature, we capture structural change by the Effective Structural Change (ESC) and Norm of Absolute Values (NAV):

$$\text{Norm of Absolute Values} \quad \text{NAV} = 0.5 * \sum_{i \in X}^n |S_{iT} - S_{i0}| \quad (1)$$

$$\text{Effective Structural Change} \quad \text{ESC} = 0.5 * \sum_{i \in X}^n |S_{iT} - S_{i0}| X \quad (2)$$

$$X = \{i\} \text{ such that } C_i > 0; \text{ with } C_i = \frac{\bar{S}_i \Delta P_i}{P_0} + \frac{\bar{P}_i \Delta S_i}{P_0}.$$

According to Vu (2017), Effective Structural Change (ESC) combines the strengths of the shift-share method and the Norm of Absolute Value (NAV) index to overcome their limitations.

ESC takes only sectors with a positive contribution to labor productivity growth, that is, where (1) productivity in the sector is increasing and its share of employment is rising; (2) the sector's productivity increases and its share of employment declines, while the effect of the former outweighs that of the latter; and (3) the sector's productivity declines and its share of employment increases, while the latter effect is larger than that of the former.

Figure 1 below graphs the ESC and NAV indices for some countries. It shows that ESC is significantly below NAV in most countries. According to Vu (2017), this means that not all structural change captured by the NAV measure would boost productivity growth.

3.2. Relationship between demographic structure on economic growth: role of structural change

Following Wei and Hao (2010) and Crespo Cuaresma et al. (2014), our empirical estimation model can be expressed as follows:

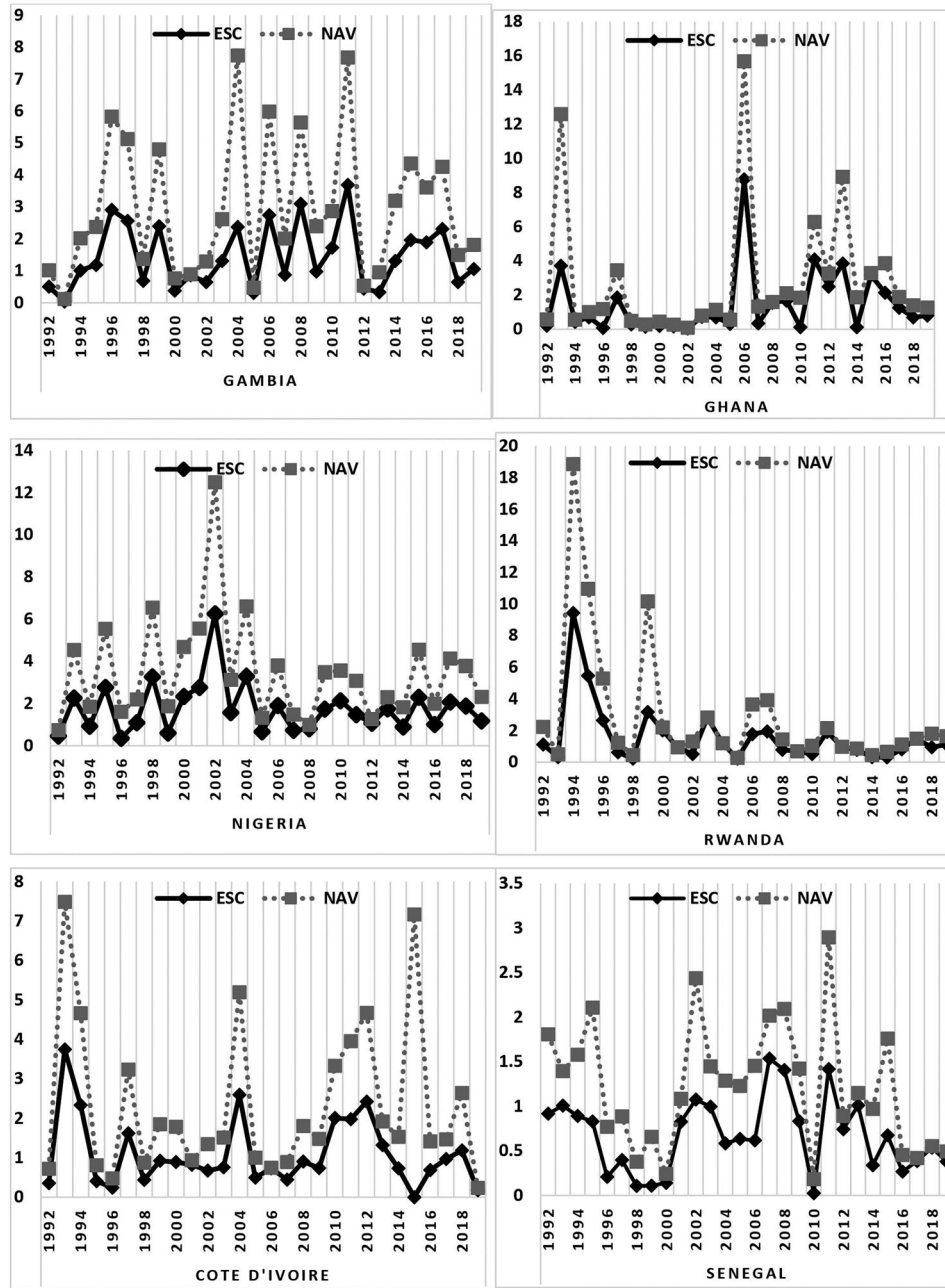


Figure 1. Effective Structural Change (ESC) and Norm of Absolute Values (NAV) Indices.

$$\begin{aligned}
 GDP_{it} = & \beta_1 + \beta_2 \text{Dependency ratio}_{it} + \beta_3 \text{STR_VAR}_{it} + \beta_4 \text{Dependency ratio} * \text{STR_VAR}_{it} + \beta_5 \text{URBAN}_{it} \\
 & + \beta_6 \text{IMPORT}_{it} + \beta_7 \text{EXPORT}_{it} + \varepsilon_{it}
 \end{aligned}
 \quad (3)$$

GDP represents a measure of the growth of real GDP per capita, $\text{Dependency ratio}_{it}$ is the demographic dependency ratio, STR_VAR_{it} represents the structural change variables such as effective structural change (ESC) and norm absolute values (NAV). As control variables, we used urban population (URBAN_{it}), imports (IMPORT_{it}), and exports (EXPORT_{it}).

Most empirical studies have focused on the endogeneity bias of demographic variables (Choudhry & Elhorst, 2010; Cruz & Ahmed, 2018; Wei & Hao, 2010; Zhang et al., 2015), using more instrumental variables (IV) or GMM panels. However, GMM or IV captures only the short-run dynamics and ignores the long-run relationship because the estimator is designed for a small period. Moreover, in the case of a small N and large T, the GMM estimator is not appropriate for the nature of the dataset. Indeed, if T is

Table 1. Unit root test in all countries.

Variables	Level		1st Difference		Order
	LL-Chu	Im-P-Shin	LL-Chu	Im-P-Shin	
GDP _{it} , lag (1)	0.0000	0.0000	–	–	I (0)
Dependency ratio _{it} , lag (1)	0.0012	0.9834	0.0004	0.0309	I (1)
ESC _{it}	1.0000	1.0000	0.1445	0.0863	I (1)
URBAN _{it}	0.0016	1.0000	–	–	I (0)
IMPORT _{it} , lag (1)	0.0065	0.0727	–	–	I (0)
EXPORT _{it} , lag (1)	0.0006	0.0301	–	–	I (0)

Note. The table shows the probability value of the unit root test (*p*-value).

large, the dynamic panel bias becomes insignificant, and a more straightforward fixed-effects estimator works (Roodman, 2006). Our analysis uses data from 26 countries in sub-Saharan Africa for 27 years (1992–2019), with some estimations on subgroups of countries according to their income (lower and middle income). The subgroups are panels of 14 low-income and 13 middle-income countries. Issues in data availability determine the choice of country.

The statistics of the different homogeneity tests in all samples and in the middle-income countries are statistically insignificant at the 5% threshold (Table A3). In other words, these results illustrate the heterogeneity of the study variables between countries in the different samples. Indeed, this disparity between the variables in the countries is illustrated in Figure 1 with the variable trends in economic structure (structural change) on the ESC and NAV variables. However, the result of the homogeneity test in low-income countries confirmed the homogeneity among countries at 5%.

The *P*-values associated with the Breush-Pagan LM dependence test presented in the Table A4 are less than 1% in 3 of the samples in the study, so the null hypothesis of independence between countries is rejected. In other words, a shock to all the variables in one country would automatically affect the other countries in the sample; this result is logical since these countries belong to the same region, i.e. they have similar characteristics (economic, environmental, and even cultural).

The unit root test presented in Table 1 below shows that the variables are integrated in the order 0 and 1.

After various control tests on our panel data, we concluded that the appropriate estimation method to handle our data is the autoregressive distributed lag model (ARDL), which uses the maximum likelihood method.

The ARDL model is based on three alternative estimators: mean group estimator (MG), pooled mean group (PMG), and dynamic fixed effects (DFE). Accepting the DFE estimator as the main analysis tool requires the strong assumption that countries' responses are the same in the short and long run, which is less compelling. The Pooled Mean Group (PMG) estimator considers a lower degree of heterogeneity because it imposes homogeneity in the long-run coefficients while allowing for heterogeneity in the short-run coefficients and error variances (Pesaran et al., 1999). The MG estimator is appropriate in many countries. This estimator is sensitive to permutations in large models and outliers (Favarra, 2003).

The *p*-value of the Hausman tests in Table A5 is above the 5% threshold, under these conditions, the PMG approach is preferable to the MG method for estimation.

The ARDL/PMG equation of our model can be written as follows:

$$\begin{aligned}
 \Delta GDP_{it} = & \phi_t(\Delta Y_{it} - \theta X_{it}) + \sum_{j=1}^{p-1} \lambda_{ij}^* \Delta GDP_{it-j} + \sum_{j=1}^{p-1} \delta_{1ij}^* Dependency\ ratio_{it-j} + \sum_{j=1}^{p-1} \delta_{2ij}^* STRVAR_{it-j} \\
 & + \sum_{j=0}^{q-1} \delta_{3ij}^* Dependency\ ratio + STRVAR_{it-j} + \sum_{j=1}^{p-1} \delta_{4ij}^* URBAN_{it-j} + \sum_{j=0}^{q-1} \delta_{5ij}^* IMPORT_{it-j} + \sum_{j=0}^{q-1} \delta_{6ij}^* EXPORT_{it-j} \\
 & + u_t + \varepsilon_{it}
 \end{aligned}
 \tag{4}$$

After the unit root test, we perform the Pedroni (2004), Kao (1999), and Westerlund (2008) tests for cointegration to examine the long-run relationships among variables. The results in Table 2 below suggest a long-run equilibrium relationship between the model variables. After establishing the existence of a cointegration relationship, we employ the ARDL/PMG panel.

Table 3 reports the ARDL/PMG short-term and long-term estimates, column 1 represents the panel estimate for all countries, column 2 represents lower-income estimates, and column 3 for middle-income

Table 2. Panel cointegration test.

	All sample	Lower-income	Middle income
Pedroni			
Modified Phillips-Perron <i>t</i>	1.0752 (0.1411)	−0.0696 (0.4722)	1.5899* (0.0559)
Phillips-Perron <i>t</i>	−14.6333*** (0.0000)	−14.0094*** (0.0000)	−6.5578*** (0.0000)
Augmented Dickey-Fuller <i>t</i>	−12.5329*** (0.0000)	−11.8451*** (0.0000)	−5.7695*** (0.0000)
Kao			
Modified Dickey-Fuller <i>t</i>	−27.8112*** (0.0000)	−22.0098*** (0.0000)	−14.5787*** (0.0000)
Dickey-Fuller <i>t</i>	−22.7656*** (0.0000)	−17.5903*** (0.0000)	−11.5363*** (0.0000)
Augmented Dickey-Fuller <i>t</i>	−15.7364*** (0.0000)	−12.9698*** (0.0000)	−7.1017*** (0.0000)
Unadjusted modified Dickey-Fuller <i>t</i>	−37.9050*** (0.0000)	−28.6908*** (0.0000)	−19.9335*** (0.0000)
Unadjusted Dickey-Fuller <i>t</i>	−23.7319*** (0.0000)	−18.1211*** (0.0000)	−12.2246*** (0.0000)
Westerlund			
Variance ratio	−2.6874*** (0.0036)	−2.4899*** (0.0064)	−1.2891* (0.0987)

Note. Probability value in parentheses *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Table 3. PMG-ARDL (1) short-term and long-term estimations.

	All countries		Lower-income		Middle-income	
	(1)	(2)	(3)	(4)	(5)	(6)
GDP						
Short-term						
ECT	−0.924*** (0.0451)	−0.586*** (0.0664)	−1.010*** (0.0608)	−0.668*** (0.0871)	−0.826*** (0.0599)	−0.506*** (0.100)
Δ.Dependency ratio	−0.342 (0.517)	−0.464 (0.435)	−0.287 (0.782)	−0.472 (0.765)	−0.631 (0.636)	−0.572 (0.423)
Δ.ESC	9.193 (23.64)		−18.78 (36.97)		44.04** (18.81)	
ΔDependency ratio*ESC	−0.160 (0.249)		0.155 (0.376)		−0.549** (0.219)	
Δ.NAV		30.23 (33.02)		33.85 (56.22)		18.38 (33.58)
Δ.Dependency ratio*NAV		−0.165 (0.350)		−0.151 (0.584)		−0.0962 (0.382)
Δ.Urban	0.519 (7.437)	0.752 (8.043)	−2.767 (10.60)	−11.63 (9.078)	1.374 (10.39)	8.672 (10.55)
Δ.Import	−0.0346 (0.0609)	0.00496 (0.0540)	−0.109 (0.0995)	−0.0848 (0.0851)	0.0680 (0.0569)	0.110** (0.0455)
Δ.Export	0.0265 (0.0650)	0.0373 (0.0702)	0.0716 (0.104)	0.0396 (0.120)	−0.00374 (0.0652)	0.0328 (0.0617)
Long-term						
Dependency ratio	−0.0979** (0.0405)	−0.236*** (0.0484)	−0.0599 (0.0660)	−0.264*** (0.0750)	−0.0921 (0.0595)	−0.109 (0.0783)
ESC	−2.291 (1.875)		−8.795 (6.155)		−5.273* (2.807)	
DS*ESC	0.0423* (0.0223)		0.107* (0.0643)		0.0986** (0.0404)	
NAV		−1.478 (1.897)		5.037 (4.212)		−5.744 (3.753)
Dependency ratio*NAV		0.0236 (0.0211)		−0.0436 (0.0441)		0.0842* (0.0506)
Urban	−0.0745 (0.0623)	−0.198*** (0.0661)	−0.0872 (0.102)	−0.198** (0.100)	0.00393 (0.0879)	−0.0184 (0.110)
Import	0.0313 (0.0209)	−0.0191 (0.0241)	0.0389 (0.0263)	−0.0157 (0.0268)	−0.0249 (0.0329)	−0.0726 (0.0468)
Export	0.0185 (0.0271)	0.0178 (0.0303)	−0.0255 (0.0415)	−0.00920 (0.0384)	0.111*** (0.0370)	0.123** (0.0526)
Constant	7.364** (2.977)	13.73*** (4.373)	6.118** (2.834)	22.79*** (4.458)	3.133 (4.097)	−1.304 (5.885)
Number of countries	26	26	14	14	12	12
Observations	702	702	378	378	324	324
Hausman test	6.30 (0.3904)	4.43 (0.6182)	9.06 (0.1706)	4.45 (0.6164)	3.39 (0.7581)	3.25 (0.6610)

Note. Standard errors in parentheses *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

countries. The short-run error correction term (ECT) is significantly negative for all estimations, confirming the cointegration relationship and long-term relation between the variables.

The long-run cointegration relationship (long-run homogeneity between countries) is confirmed in Table 3, and the Pool Mean Group (PMG) estimator is valid and more efficient than the mean group (MG) estimator.

In the short-term estimates, we can see that, in sub-Saharan countries and low-income sub-Saharan countries, no variable is significant, which underlines an important aspect of this study: that demographic structure and structural change are two factors that evolve and are best appreciated in the long term. Only middle-income countries have significant variables. The coefficient of effective structural change (ESC) presents a significant and positive effect on economic growth, which means that a one percentage point increase in effective structural change would increase the growth of GDP per capita by 44.04 percentage points at the 5% level. This finding is in line with the results of Vu (2017). Indeed, a short-term shift in the labor force due to improved labor productivity influences economic growth. However, the coefficient of the interaction term between demographic structure and structural change was negative and significant at the 5% probability level. In other words, the acceleration of demographic transition associated with structural change has a negative effect on economic growth in the short term. We can also see that the gain in economic growth from structural change is greater than the decline in economic growth.

In the long term, the demographic structure variable or age dependency ratio is negatively associated with economic growth at the 1 and 5% significance levels in all sub-Saharan countries and low-income sub-Saharan countries. For instance, a 1% decline in the age dependency ratio in sub-Saharan countries (column 1) increases the growth of GDP per capita by 0.0979%, *ceteris paribus*. This negative relationship was confirmed by Kelley and Schmidt (2001) and Wei and Hao (2010). In these sub-Saharan African countries, the dependency ratio is led by youth dependency; therefore, the demographic structure's effect on economic growth can be mainly attributable to the substantial decline in youth dependency. This result also shows the effect of demographic dividend potential through an increasingly working-age population and declining youth-dependent population on economic growth.

The coefficient of the Effective Structural Change index presents counterintuitive results, as shown in Column 5. Indeed, in middle-income countries, structural change has a negative effect on economic growth in the long term, which means that a one percentage point increase in effective structural change would reduce the growth of GDP per capita by 5.273 percentage points at the 10% level. This negative result on economic growth could be explained by the lack of innovation or industrialization in the long term. Indeed, if companies can increase their productivity by using an existing technology or industrialization rather than by investing in new technologies or production capacity, this may reduce the incentives to innovate. A decline in innovation or industrialization can in turn lead to a decline in long-term economic growth, as innovation (technical progress) is a key driver of long-term economic growth. Structural change that is not accompanied by technological innovation can lead to inefficient use of resources, limiting productivity gains and overall economic growth.

This finding is in line with McMillan et al. (2014) and McMillan (2011), who find that structural change has had a negative effect on economic growth in Africa. A nearly absent industrialization stage in Africa's structural change process is a concern because it might eventually reduce overall productivity growth (Diao et al., 2017).

The coefficients of the interaction term between demographic structure and structural change (ESC and NAV) are positive and significant at the 1 and 5% probability levels. In other words, a fall in the demographic dependency ratio, combined with a rise in labor productivity, significantly increases economic growth. This result is consistent with Lopes and Par (2019), who argues that the impact of demographic behavior on economic growth is amplified when labor productivity is intensive, producing more value-added and efficient production. He also argues that structural change through industrialization is relevant in the translation of Africa's youth bulge into a demographic dividend. This result could be considered as the second demographic dividend presented by Mason et al. (2016), which affects economic growth through labor productivity growth.

Other expected results were found in the middle-income countries. The export coefficients are positive and significant at the 1% level. Thus, increasing exports increases the economic growth of these countries.

However, in Columns 2 and 4, we find unexpected results. The coefficients of the urban population are negative and significant at 1 and 5%; therefore, an increase in urban population reduces the growth of GDP per capita, *ceteris paribus*. According to some authors (e.g. Chen et al., 2014), economic growth may create conditions that organically drive migration from rural to urban areas, but the reverse, that is, urbanization, will not necessarily drive economic growth.

3.3. Robustness check

In this section, we discuss the empirical validity of our estimated results in the previous section and conduct some robust estimations.

Although the ARDL estimator is appropriate for our study, it does not take endogeneity problems into account. In the case of panel data, Kao and Chiang (1999) showed that these two techniques lead to estimators that are asymptotically distributed according to a normal distribution of zero means. The Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) models are efficient methods for estimating systems of cointegrated variables, as well as for performing tests on the cointegrating vectors. FMOLS and DOLS produce consistent, efficient, and unbiased estimates in the long run.

FMOLS addresses endogeneity issues and provides consistent estimates even when the explanatory variables are endogenous (Phillips & Hansen, 1990). This is crucial in the context of demographic structure, structural change, and economic growth, where the relationship might be subject to reverse causality or omitted variable bias. Moreover, according to Wei and Hao (2010), the dependency ratio is contemporaneous with the economic growth rate, and this relationship may suffer from endogeneity.

The findings from FMOLS estimation in Table 4 are aligned with those obtained from the ARDL-PMG. Dependency ratio and urban population variables have a negative relationship with economic growth at the 1 and 5% significance levels in all sub-Saharan countries, low-income and middle-income sub-Saharan countries. In addition, these results found that exports and Dependency ratio*NAV have a positive impact on economic growth. However, the FMOLS results are different from ARDL-PMG results, with a positive impact of NAV on economic growth.

According to Kao and Chiang (2000), the OLS estimator suffers from a bias problem, which the FM-OLS estimator does not substantially improve. Therefore, the DOLS outperforms the FM-OLS estimator. Following Kao and Chiang (2000), we use the DOLS estimator as an alternative estimator.

The DOLS results in Table 5 show only two significant results. First, structural change in sub-Saharan countries has a negative impact on economic growth in the long term. Second, the dependency ratio*ESC had a positive and significant effect on economic growth. This finding confirms that the interaction between demographic structure and economic growth has a positive impact on economic growth.

Table 4. FMOLS estimation results.

Variables	All countries		Lower-income		Middle-income	
	(1)	(2)	(3)	(4)	(5)	(6)
Dependency ratio	−0.0730*** (0.0236)	−0.0636** (0.0324)	−0.0992*** (0.0385)	−0.0627 (0.0521)	−0.0815** (0.0323)	−0.153*** (0.0219)
ESC	−0.413 (0.454)		−0.651 (1.191)		−0.227 (0.546)	
Dependency ratio*ESC	0.00565 (0.00563)		0.00839 (0.0136)		0.00302 (0.00718)	
Urban	−0.0696*** (0.0203)	−0.0600*** (0.0216)	−0.0580** (0.0286)	−0.0424 (0.0297)	−0.0858*** (0.0326)	−0.0905*** (0.0152)
Import	−0.0162 (0.0193)	−0.0114 (0.0205)	−0.0443 (0.0304)	−0.0450 (0.0310)	−0.0232 (0.0276)	−0.0243* (0.0130)
Export	0.0266 (0.0223)	0.0242 (0.0236)	0.0804* (0.0422)	0.0827* (0.0432)	0.0331 (0.0302)	0.0500*** (0.0141)
NAV		−0.346 (2.537)		0.523 (4.550)		−10.50*** (2.041)
Dependency ratio*NAV		0.0163 (0.0281)		0.00823 (0.0482)		0.153*** (0.0258)
Observations	755	755	391	391	363	363
R-squared	−0.021	−0.009	−0.053	−0.016	−0.014	0.110
Number of countries	26	26	14	14	12	12

Note. Standard errors in parentheses *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Table 5. DOLS estimation results.

Variables	All countries		Lower-income		Middle-income	
	(1)	(2)	(3)	(4)	(5)	(6)
Dependency ratio	−0.0576 (0.0579)	−0.0372 (0.0595)	−0.0522 (0.0825)	−0.0593 (0.0808)	−0.0511 (0.0724)	−0.0629 (0.0752)
ESC	−2.164*** (0.200)			0.0300 (0.543)	−5.069*** (0.193)	
Dependency ratio*ESC	0.0284*** (0.00249)			0.00675 (0.00625)	0.0562*** (0.00254)	
Urban	−0.0780 (0.0921)	−0.0724 (0.0899)	−0.0610 (0.139)	−0.0645 (0.140)	−0.0869 (0.106)	−0.0925 (0.102)
Import	0.00671 (0.0200)	0.00421 (0.0198)	−0.0108 (0.0282)	−0.0132 (0.0283)	0.0102 (0.0241)	0.00469 (0.0237)
Export	0.00849 (0.0274)	0.0116 (0.0271)	0.0363 (0.0444)	0.0439 (0.0446)	−0.00448 (0.0292)	0.0114 (0.0288)
NAV		0.762 (2.087)	−0.0924 (3.898)			−4.441 (3.657)
Dependency ratio*NAV		0.000652 (0.0236)	0.00844 (0.0413)			0.0659 (0.0480)
Observations	624	624	336	336	288	288
R-squared	0.091	0.105	0.149	0.137	0.138	0.208
Number of countries	26	26	14	14	12	12

Note. Standard errors in parentheses. *** $p < 0.01$.

4. Conclusion and recommendations

The demographic dividend is crucial for the developing countries of sub-Saharan Africa whose demographic transition is undergoing, but its full benefit is difficult to realize due to the efficient use of labor and the lack of structural change. Structural change is an essential channel for the effect of demographic structure on economic growth, yet studies on this issue are limited, especially for developing countries. This study examined the impact of demographic structure on economic growth in the context of structural change. Using a database accessible from 1992 to 2019, our estimates suggest that the demographic structure in sub-Saharan Africa favors economic growth. This result reveals that the demographic transition in sub-Saharan Africa offers opportunities to benefit from the demographic dividend, which occurs through effective structural change, by increasing labor productivity growth. In middle-income Sub-Saharan African countries, PMG and DOLS estimates show that structural change has a negative effect on economic growth. This relationship has been confirmed with recent empirical work (McMillan et al., 2014). All countries that remain poor have failed to achieve structural change, that is, they have been unable to diversify away from agriculture and the production of traditional goods into manufacturing and other modern activities. Most of the difference in growth between Asia and the developing countries of Africa can be explained by the contribution of structural change to overall labor productivity (McMillan et al., 2014; McMillan, 2011).

In light of the aforementioned conclusions, this paper primarily puts forward the following recommendations:

Our findings suggest that lowering demographic dependency promotes economic growth in Sub-Saharan African countries, so policymakers should insist on their population policies. They should also encourage family planning and the schooling or education of young girls in order to accelerate the demographic transition.

Given that the economic structure of an economy is endogenous to the structure of its factor endowments, and that sustainable economic development is determined by changes in factor endowments and ongoing technological innovation (Lin, 2012). Policymakers should implement sectoral policies, such as industrial policies that foster structural change and innovation policies. Enhancing structural change for long-term economic growth translates into domestic companies acquiring technologies, and training opportunities, and improving human capital accumulation.

Despite its novel contribution, this study presents noticeable limitations. Firstly, the study does not present a country-by-country analysis, which would help to understand the heterogeneity among the countries studied. Secondly, the study's indicators use the dependency ratio and ESC as demographic and structural variables respectively. This demographic variable could overlook the nuanced impacts of demographic characteristics such as education levels, and health status, which could also significantly influence economic outcomes. Effective Structural Change (ESC) as an indicator may not adequately capture all dimensions of

structural change, such as job quality or the role of the informal sector, which are crucial in many African economies. Moreover, as this measure of structural change is derived from modeled estimates - and not from household survey data - it does not show whether current structural change is reducing poverty.

Future studies should extend to country analyses in these sub-Saharan economies and include other indicators such as education variables, etc.

Note

1. Support ratio defined as the ratio of the effective (productive) employed population to the effective (non-productive) dependent population.

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Author contributions

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Data availability statement

Data is available on request from the author.

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Appendix

Table A1. Description of variables.

Variables	Description of variables	Source
Economic growth		
GDP	Growth of real GDP per capita	WDI, 2020
Structural change variables		
ESC	Effective Structural Change	WVu (2017)
NAV	Norm of absolute values	WVu (2017)
Demographic structure variables		
DS	Age dependency ratio	World Population Perspective (WPP, 2020)
Other control variables		
Urban Population	Urban population	(WDI, 2020)
Export	Exports	(WDI, 2020)
Import	Imports	(WDI, 2020)

Table A2. List of countries in the panel.

Low income		Middle income	
Burkina-Faso	Malawi	Benin	Botswana
Burundi	Tchad	Cameron	Cote d'Ivoire
Mozambique	Gambia	Congo	Comoros
Niger	Guinea-Bissau	Gabon	Ghana
Rwanda	Uganda	Guinea	Nigeria
Togo	Sierra Leone	Senegal	South Africa
Sudan	Mali		

Table A3. Homogeneity test.

	F test	p-Value
All sample	5.21	0.0001
Lower-income	1.14	0.3372
Middle-income	8.86	0.0000

Source: Authors' calculation.

Table A4. Dependence test of Breush-Pagan LM.

	Breush-Pagan LM		Pesaran's test	
	Statistics	p-Value	Statistics	p-Value
All sample	Chi ² (6)=335.61	0.0000	5.430	0.0000
Lower-income	Chi ² (6)=228.47	0.0000	2.023	0.0431
Middle income	Chi ² (6)=58.95	0.0000	0.911	0.3624

Source: Authors' calculation.

Table A5. Hausman Test.

	Statistic	p-Value
All sample	Chi ² (6)=6.17	0.6182
Lower-income	Chi ² (6)=9.06	0.1706
Middle-income	Chi ² (6)=3.39	0.7581

Source: Authors' calculation.