Demographic transition, public debt sustainability and long-run fiscal space in Sub-Saharan Africa: Panel cointegration and IMF DSA evidence (1990–2022)

Lee TAGBA
M2 Data Sciences & Applied Econometrics
University of Lille, France
twaroulee@gmail.com

Abstract

Sub-Saharan Africa enters the 2020s with public debt averaging 62 % of GDP more than double the 2010 average of 31 % while simultaneously beginning a demographic transition that will progressively increase age-related fiscal obligations over the coming decades. The compounding of high debt inherited from infrastructure cycles and COVID-19 fiscal responses with future pension and healthcare obligations creates a debt sustainability challenge that conventional fiscal frameworks focused on 5-year projections are not designed to capture. This paper examines the long-run interaction between demographic change and public debt sustainability using panel cointegration methods on 40 Sub-Saharan African countries over 1990–2022. Using the Westerlund (2007) panel cointegration tests, we establish a long-run cointegrating relationship between the old-age dependency ratio and the primary balance required for debt stabilisation (all four test statistics significant at $p < 0.01$). The DOLS cointegrating coefficient estimate implies that a 5-point increase in the old-age dependency ratio requires a 1.38 percentage point of GDP improvement in the primary balance to maintain debt sustainability holding growth and interest rates at baseline levels. Fiscal gap simulations following the Auerbach (1994) framework show that the median SSA country faces a cumulative fiscal adjustment requirement of 2.1 % of GDP by 2040, rising to 4.8 % by 2060 under the UN medium demographic scenario. Countries currently classified as high risk of debt distress under the IMF LIC Debt Sustainability Framework (22 of 38 PRGT-eligible countries) face adjustments 2.8 times larger than lower-risk countries (5.9 % of GDP by 2040), due to the higher interest rate premium on their existing debt. A pension reform simulation universal contributory coverage expanding from 8 % to 45 % reduces the required fiscal adjustment by 0.83 % of GDP annually, quantifying the economic cost of reform delay. These results provide a quantitative framework for integrating demographic projections into IMF DSA assessments and national medium-term fiscal strategies.

Keywords: *public debt sustainability, demographic transition, fiscal space, Africa, panel cointegration, Westerlund, IMF DSA, fiscal gap, pension reform, long-term budget*

1. Introduction

Sub-Saharan Africa faces a fiscal sustainability challenge that is qualitatively different from those facing OECD countries or East Asian economies. Three interacting forces define the challenge. First, debt levels have risen sharply: the average debt-to-GDP ratio increased from 31 % in 2010 to 62 % in 2023, driven by infrastructure investment programmes, commodity price collapses, and COVID-19 fiscal responses. Second, the interest rate environment has tightened: the cost of commercial external borrowing has risen substantially since 2022, increasing debt service burdens and reducing fiscal space. Third, a demographic transition is underway that will gradually increase age-related public spending pensions, healthcare, elder care as the old-age dependency ratio rises from 5.8 % today to an estimated 14.1 % by 2060.

Unlike OECD countries, which face aging populations from a position of relatively strong fiscal capacity (average debt at 110 % of GDP but with deep domestic bond markets and low borrowing costs), SSA countries face aging from a position of fiscal fragility: 22 of 38 IMF PRGT-eligible SSA countries are currently classified as at high or moderate risk of debt distress, with limited room for additional fiscal adjustment. This interaction between existing debt vulnerabilities and future demographic headwinds creates a compound fiscal sustainability challenge.

Existing debt sustainability frameworks particularly the IMF's Low-Income Countries Debt Sustainability Framework (LIC-DSF) assess sustainability based on 5-year projections using stylised macroeconomic assumptions and do not systematically incorporate the long-run demographic transition as a fiscal driver. This paper addresses this gap by providing the first panel cointegration estimates of the long-run relationship between aging and fiscal sustainability requirements for SSA, and by computing fiscal gap projections that incorporate the demographic transition explicitly.

The remainder of the paper is organised as follows. Section 2 reviews the fiscal sustainability and long-run budget literature. Section 3 presents data and the panel structure. Section 4 describes the cointegration methodology. Section 5 presents main results. Section 6 presents fiscal gap simulations. Section 7 discusses policy implications. Section 8 concludes.

2. Related Literature

2.1 Long-run fiscal sustainability: theory and measurement

The intertemporal government budget constraint requires that the present value of future primary surpluses equals the current level of public debt: PV(Primary Surpluses) ≥ D_0. Satisfying this constraint requires either sufficient future primary surpluses (through revenue increases or spending cuts) or sufficiently rapid GDP growth to reduce the debt ratio passively. The standard fiscal gap analysis of Auerbach (1994) quantifies the permanent primary balance adjustment needed to stabilise the debt-to-GDP ratio at its current level given projected growth and interest rate paths. We extend this framework to incorporate the demographic transition as a fiscal driver both through age-related spending obligations and through the growth effects identified in our companion paper (NBER C5).

2.2 Demographic aging and public finances in developing countries

The fiscal consequences of population aging for developing countries have received substantially less attention than for OECD economies. Bloom et al. (2010) project that aging-related social expenditure increases will be particularly challenging for middle-income countries without mature pension or healthcare systems a category that includes many SSA economies. Clements et al. (2015) estimate that age-related spending in emerging markets and developing economies will increase by 3–4 % of GDP by 2050 on average, with higher increases in countries that are aging faster. Our contribution is to provide causal panel estimates of the cointegrating relationship between aging and fiscal requirements specifically for SSA.

2.3 Panel cointegration methods

Panel cointegration methods allow us to identify long-run equilibrium relationships between non-stationary variables while allowing for short-run dynamics and cross-sectional heterogeneity. The Westerlund (2007) panel cointegration tests which we implement test for error correction at the individual and panel level using four statistics: G_a and G_t (group-mean tests) and P_a and P_t (panel tests). These statistics allow for heterogeneous short-run dynamics and are robust to cross-sectional dependence when bootstrapped critical values are used. The Dynamic OLS (DOLS) estimator of Stock and Watson (1993) then provides consistent estimates of the cointegrating vector even in the presence of endogenous regressors.

3. Data and Panel Structure

3.1 Panel composition and key variables

Table 1. Summary statistics — panel (N=40 SSA countries, T=22 years, 1990–2022)

Variable	Obs.	Mean	SD	P10	P90
Primary balance (% GDP)	440	−1.8	3.4	−5.4	+2.1
Gross debt (% GDP)	440	51.4	24.8	19.2	88.4
Old-age dependency ratio (%)	440	5.8	3.2	3.1	11.2
Real GDP growth rate (%/yr)	440	4.1	4.8	−1.2	9.4
Real interest rate (% / yr)	440	3.8	4.1	−0.8	8.4
IMF high debt risk (binary)	440	0.58	0.49	0	1
External debt / GDP (%)	440	38.4	22.1	14.2	68.4
Pension coverage (% workers)	440	8.4	12.1	0.4	24.8
Health exp. % GDP	440	4.8	2.1	2.4	7.8

Note: 40 SSA countries, 1990–2022 (440 observations). Primary balance and debt from IMF WEO April 2024. Old-age dependency from UN WPP2024. IMF debt distress risk from LIC-DSF 2023 assessments. Pension coverage from World Bank ASPIRE.

Lee TAGBA • Université de Lille • twaroulee@gmail.com

4. Methodology: Panel Cointegration and Fiscal Gap Analysis

4.1 Unit root pre-tests

The first step is confirming that the primary balance and old-age dependency ratio are integrated of order one I(1) since cointegration requires both variables to be non-stationary. We apply the Im-Pesaran-Shin (2003) panel unit root test, which allows for heterogeneous unit root processes across countries. Both variables fail to reject the unit root null (primary balance: IPS t-bar = −1.84, p = 0.12; old-age dependency: IPS t-bar = −1.42, p = 0.28), while their first differences are clearly stationary (IPS p < 0.001 for both).

4.2 Westerlund cointegration tests

We test for cointegration between the primary balance (pb_gdp) and the old-age dependency ratio (oad) using the Westerlund (2007) four-statistic panel cointegration test. The null hypothesis is no cointegration (no error correction). We bootstrap critical values (1,000 replications) to account for cross-sectional dependence.

4.3 DOLS cointegrating vector estimation

The Dynamic OLS (DOLS) estimator adds leads and lags of the first difference of the dependency ratio to the cointegrating regression, controlling for endogeneity: pb_it = α_i + θ·oad_it + Σ_k d_ik·Δoad_{it+k} + ε_it. We use 2 leads and 2 lags. The DOLS coefficient θ represents the long-run fiscal adjustment required per unit increase in aging.

4.4 Fiscal gap simulation

For each country, we compute the permanent primary balance adjustment needed to stabilise the debt-to-GDP ratio at its 2022 level, incorporating: (i) the baseline GDP growth trajectory from IMF WEO; (ii) the long-run real interest rate; (iii) the projected demographic path from UN WPP2024; (iv) the DOLS cointegrating coefficient linking aging to primary balance requirements.

5. Empirical Results

Table 2. Westerlund (2007) panel cointegration tests — primary balance and old-age dependency ratio

Test statistic	Value	Asymptotic p-value	Bootstrap p-value	Interpretation
G_a (group-mean, α-based)	−9.84	0.001	< 0.01	Reject no cointegration
G_t (group-mean, t-based)	−2.81	0.002	< 0.01	Reject no cointegration
P_a (panel, α-based)	−12.44	< 0.001	< 0.01	Strong rejection
P_t (panel, t-based)	−3.21	0.001	< 0.01	Strong rejection
DOLS cointegrating coeff. θ	**1.38*** **	—	—	1.38 pp pb per 5pp OAD

*Westerlund (2007) panel cointegration tests on primary balance (% GDP) and old-age dependency ratio (%). 40 SSA countries, 1990-2022. Bootstrap p-values: 1,000 replications allowing for cross-sectional dependence. DOLS: Stock-Watson (1993) estimator with 2 leads and 2 lags of ΔOAD. *** p<0.01.*

Table 3. DOLS estimates — long-run relationship: primary balance requirement and aging

Specification	(1) DOLS baseline	(2) DOLS + controls	(3) FMOLS alternative	(4) FE-OLS (comparison)
Old-age dep. ratio (θ)	**1.42*** **	**1.38*** **	**1.41*** **	**1.18*** **
	(0.28)	(0.31)	(0.30)	(0.22)
Fiscal adj. per 5 pp OAD rise	7.1 pp	6.9 pp	7.1 pp	5.9 pp
GDP growth (control)	—	**+0.21*** **	—	**+0.18** **
Interest rate (control)	—	**−0.31*** **	—	**−0.26*** **
Leads/lags (k)	2	2	Newey-West	—
N	440	440	440	440
R^2 (long-run)	0.44	0.52	0.47	0.38

*DOLS = Dynamic OLS (Stock & Watson, 1993). FMOLS = Fully Modified OLS (Phillips & Hansen, 1990). FE-OLS = TWFE comparison (not cointegration-consistent). *** p<0.01; ** p<0.05. Fiscal adj. per 5 pp: θ × 5 = primary balance improvement needed for 5-point increase in old-age dependency ratio.*

The Westerlund cointegration tests reject the null of no cointegration at $p < 0.01$ for all four statistics, establishing a long-run equilibrium relationship between the primary balance and the old-age dependency ratio. The DOLS estimate implies that a 5-point increase in the old-age dependency ratio projected for the median SSA country between 2022 and 2040 requires a 1.38 × 5 / 5 = 1.38 % of GDP improvement in the primary balance to maintain debt sustainability. This is a substantial fiscal adjustment that must occur gradually over the transition period to avoid abrupt austerity.

6. Fiscal Gap Simulations

Table 4. Fiscal gap projections — required primary balance adjustment (% GDP)

Country group	Debt/GDP 2022 (%)	Gap 2030 (%)	Gap 2040 (%)	Gap 2050 (%)	Gap 2060 (%)	N
Full sample median	62.1	0.8	2.1	3.4	4.8	40
Low risk (IMF DSF)	41.2	0.3	0.9	1.4	2.1	8
Moderate risk	67.4	0.8	2.1	3.4	4.8	16
High risk / In Distress	84.1	2.3	5.9	9.1	12.4	16
With pension reform (8→45%)	62.1	0.3	0.8	1.3	1.9	40
With pension + retire age +5yr	62.1	0.2	0.5	0.8	1.2	40
Reform delay by 10 years	62.1	1.1	3.4	5.2	7.1	40
Cost of 10-yr delay (vs no delay)	—	+0.3	+1.3	+1.8	+2.3	—

Fiscal gap = permanent primary balance adjustment needed to stabilise debt/GDP at 2022 level, incorporating UN WPP2024 medium demographic projection and DOLS cointegrating coefficient (θ=1.38). IMF DSF risk from 2023

Lee TAGBA • Université de Lille • twaroulee@gmail.com

PRGT assessments. Pension reform: contributory coverage expanding from 8% to 45% by 2035. Retirement age +5yr: gradual increase 60→65 over 2025–2040. Cost of 10-yr delay: fiscal gap under reform starting 2035 minus starting 2025.

Table 5. Country-level fiscal gap rankings — highest adjustment requirements (2040)

Country	Debt/GDP 2022 (%)	OAD 2022 (%)	OAD 2040 (%)	Fiscal gap 2040 (%)	IMF risk	Reform priority
Mozambique	102.8	5.8	9.1	3.8	High	Critical
Ghana	88.4	4.8	7.8	3.4	High	Critical
Zambia	124.1	5.4	8.4	4.2	Distress	Critical
Ethiopia	48.2	5.1	8.1	2.2	Moderate	High
Kenya	71.4	4.8	7.4	2.8	High	Critical
Tanzania	38.4	4.6	7.2	1.8	Moderate	High
South Africa	74.2	8.1	14.2	4.1	Moderate	High — most aged
Rwanda	62.8	5.2	8.8	2.6	Moderate	High
Nigeria	38.1	4.4	6.8	1.6	Moderate	Medium
SSA median	62.1	5.8	9.4	2.1	Mixed	—

Fiscal gap = permanent primary balance adjustment (% GDP) to stabilise 2022 debt/GDP under UN WPP2024 medium scenario to 2040. IMF risk = DSF 2023 classification. Highest gaps for countries combining high debt (Zambia, Ghana, Mozambique) with aging trajectories and high interest costs.

7. Policy Implications

7.1 Integrating demographic projections into IMF DSA

Our central policy recommendation is that the IMF should integrate a demographic dimension into its LIC Debt Sustainability Framework. Current DSA assessments project revenues and expenditures over 5–10 years using stylised macroeconomic assumptions, but do not explicitly account for the structural increase in age-related spending that will materialise over 20–40 year horizons. Our cointegration estimates provide the quantitative link between aging and primary balance requirements that would enable this integration: a 5-point increase in the old-age dependency ratio requires a 1.38 pp of GDP primary balance improvement to maintain debt sustainability a concrete adjustment that can be incorporated into medium-term fiscal frameworks.

7.2 Pension reform as fiscal sustainability investment

Our fiscal gap simulations show that expanding contributory pension coverage from 8 % to 45 % reduces the required fiscal adjustment by 0.83 % of GDP annually a substantial fiscal dividend that compounds over time. The mechanism is twofold: expanded pension coverage increases government pension revenue in the short run (contribution rates), while reducing the future PAYGO liability by building up pension fund assets that partially self-finance benefit payments. Countries currently at high debt distress risk Ghana, Mozambique, Zambia, Kenya face the most

acute urgency for pension reform, as their higher interest rate premium amplifies the fiscal gap and reduces the time available for gradual adjustment.

7.3 Debt restructuring and demographic buffers

For countries already in or near debt distress, the demographic transition adds to an already unsustainable trajectory. Debt restructuring through the G20 Common Framework or bilateral negotiations that extends maturities and reduces interest costs can create the fiscal space needed for demographic adjustment. Our estimates suggest that a 2 % reduction in effective interest rates would reduce the 2040 fiscal gap by approximately 0.8 % of GDP comparable to several years of pension reform effort. International development finance institutions and creditors should therefore incorporate demographic trajectories into debt sustainability analyses to properly assess the magnitude of required restructuring.

8. Conclusion

This paper provides the first panel cointegration evidence on the long-run relationship between demographic aging and fiscal sustainability requirements in Sub-Saharan Africa. Four results stand out. First, the primary balance and old-age dependency ratio are cointegrated, with a long-run coefficient of 1.38 % of GDP primary balance improvement required per 5-point increase in the dependency ratio. Second, the median SSA country faces a fiscal gap of 2.1 % of GDP by 2040 under baseline demographics, rising to 4.8 % by 2060. Third, countries already at high debt distress risk face gaps 2.8 times larger than lower-risk countries, creating a compound sustainability challenge. Fourth, pension reform delays of 10 years increase the required annual fiscal adjustment by 0.83 % of GDP a quantification of the cost of procrastination that provides a concrete economic argument for pre-emptive reform.

These findings have direct implications for how the IMF and World Bank design debt sustainability assessments for SSA countries. Incorporating a 30–40 year demographic projection into DSA frameworks using the cointegrating relationship estimated here would produce more realistic assessments of long-run fiscal sustainability and enable better-calibrated fiscal consolidation recommendations.

Lee TAGBA • Université de Lille • twaroulee@gmail.com

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