

Changing Interest Rates

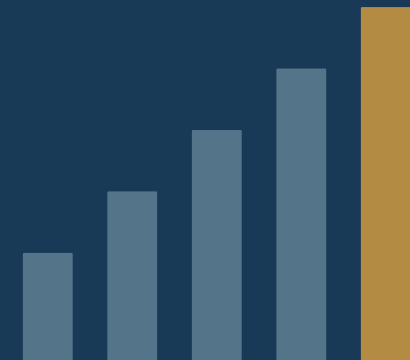
Implications for Pension Funds, Insurers and Savers

Reinvestment risk. Real returns. Asset–liability matching.

Ghanaian evidence and transparent interest-rate / inflation scenarios

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RESEARCH BRIEFING | PUBLICATION EDITION | SEPTEMBER 2026



EVIDENCE CUT-OFF
20 SEPTEMBER 2026

Rates: through June 2026

Pensions: 2025 | Insurers: 2024

Read income, purchasing power and funding together

Three analytical pillars; observed Ghanaian data are separate from hypothetical stress tests.

01 INCOME & REAL RETURNS

Rate and inflation observations; pension assets; reinvestment schedules; net real returns and fee exposure.

Ghana evidence & accounting | pp.7–23

Methods / empirical annex 61–71

02 ASSETS & LIABILITIES

Exact bond revaluation; duration and convexity; funding ratios; yield-curve twists; indexed benefits and liquidity.

Scenarios and ALM | pp.24–46

Technical appendix 72–78

03 SAVERS & DECISION USE

Accumulation and drawdown; sequence risk; institutional dashboards; source records, calculations and release controls.

Savers and empirical design | pp.47–71

References 79–82

Synthesis 83

Question, evidence, findings and decision use

Observed data • exact accounting • conditional stress tests • separately attributed causal evidence.

QUESTION	How do rate and inflation changes affect reinvestment income, purchasing power and the capacity to meet promised payments?
EVIDENCE	Five dated rate snapshots; pension AUM and allocations, 2021–2025; BNSSS return / cash-flow history; qualified 2024 insurer data.
METHOD	Exact scale–mix accounting, concentration indices, flow-adjusted return illustrations, cash-flow valuation and assumption-based sensitivity.
FINDINGS	Derived pension GoG holdings rose GHS 3.82 bn in 2024–2025 despite a 10.3 pp share fall. Nominal-model zero-surplus yield: 8.56% (base 12%).
DECISION USE	Measure actual maturity, liability and member-flow exposure before interpreting income relief, funding adequacy or investment performance.

SCOPE & INTERPRETATION

Rates: five dates to June 2026.
Pensions: 2021–2025; insurers: 2024.

Scenarios are conditional, not forecasts.

Foreign event estimates are not Ghanaian effects.

Data, code and author’s notes: companion ZIP.

Authored by Dr. Felix Larry Essilfie | Evidence cut-off: 20 September 2026 | Independent IDER research

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A fall in rates has different effects on income and funding

Observed evidence and modelled results have different labels and denominators.



The key distinction is between what is earned now, what can be reinvested later, and what must be paid to members or policyholders. A favourable movement in one measure does not establish an improvement in the others.

The 94.4% funding ratio is a hypothetical model result, not an estimate for any Ghanaian fund or insurer.

Use each dataset only for the claim it can support

Public-data diagnostics, independent numerical checks and conditional financial models are kept distinct.

Table 1. Evidence layers, coverage and interpretation

Layer	Coverage	Permitted interpretation
Rate and CPI observations	Five dated snapshots: Dec 2024–Jun 2026	Benchmark movements; not realised investor returns
Private pensions	AUM and eight allocation classes, 2021–2025	Aggregate exposure; not duration or beneficiary return
Insurance investments	Approximate 2024 life / non-life totals	Dated scale; incomplete audited reporting
Modelled scenarios	Declared cash flows, curves, inflation and fees	Conditional valuation and income sensitivity
Institution-specific inference	No matched asset–liability or member records	No solvency, causal or individual suitability conclusion

Sources: BoG (2026; retained inputs); NPRA (2025 report); FSC Ghana (2024 review); IDER calculations. [S01](#), [S02](#), [S03](#).

Reinvestment, valuation, inflation and liquidity are separate risks

Assess the exposure channel before interpreting an interest-rate change.

Table 2. Risk channels and measurement objects

Risk	Exposure measure	Question to resolve
Reinvestment	Cash maturing / resetting by month; new purchases	How much future income changes and when?
Valuation	Cash-flow PV, duration, convexity and key-rate exposure	What happens to market value today?
Inflation	Net holding-period return versus matched inflation	Is purchasing power preserved?
Liability mismatch	Asset and liability sensitivities on consistent bases	Does surplus improve or deteriorate?
Liquidity / options	Payment dates, surrender stress and sale haircuts	Can commitments be paid without forced sales?

The benefit promise determines who bears the rate risk

Distinguish funded account balances from formula-based or guaranteed commitments.

Formula-based pension

Benefits depend on scheme rules, salary history and service. Contributions, investment income, longevity and indexation all affect financing.

Account-based saving

The member's accumulated balance reflects contributions, costs and returns. Lower yields affect accumulation and the income purchasable at retirement.

Insurance contract

Guaranteed, participating and linked benefits distribute risk differently. Separate policyholder promises from shareholders' economic exposure.

The modelled funded liability book is not an actuarial valuation of the partially funded SSNIT scheme.

Rates and inflation changed at different speeds

Retained selected snapshots; rates are annual percentages and CPI is trailing year-on-year inflation.

Table 3. Observed rates and inflation

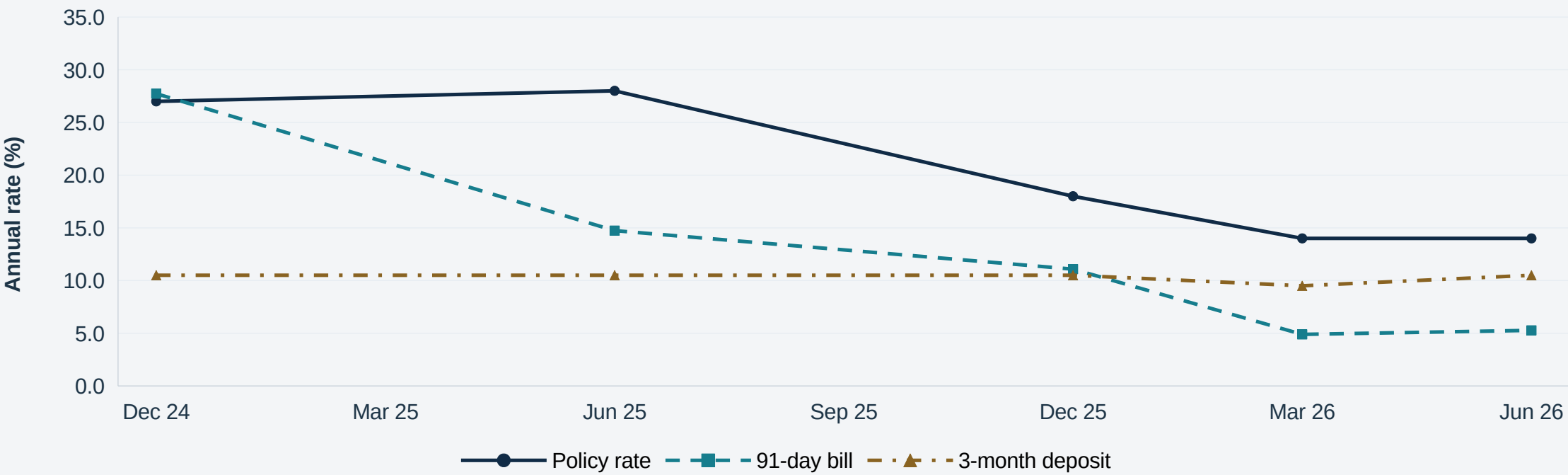
Observation	CPI y/y	MPR	91-day bill	3-month deposit	Average lending
2024-12	23.82	27.00	27.73	10.50	30.25
2025-06	13.67	28.00	14.74	10.50	27.00
2025-12	5.39	18.00	11.08	10.50	20.45
2026-03	3.22	14.00	4.89	9.50	17.74
2026-06	5.30	14.00	5.27	10.50	15.64

No observation between these dates is interpolated. A quoted short-term yield is not a one-year realised investment return.

The deposit-rate snapshot did not track the full bill-rate decline

Retained official annual-rate quotes; unequal date gaps are preserved. Lines connect five observations only.

Figure 1. Policy, bill and deposit-rate snapshots



June-to-June: bill rate -9.47 pp; MPR -14.00 pp; three-month average deposit rate unchanged at 10.50%.

A same-date yield–inflation comparison is only a diagnostic

The denominators are aligned by date, but the cash-flow horizons are not matched.

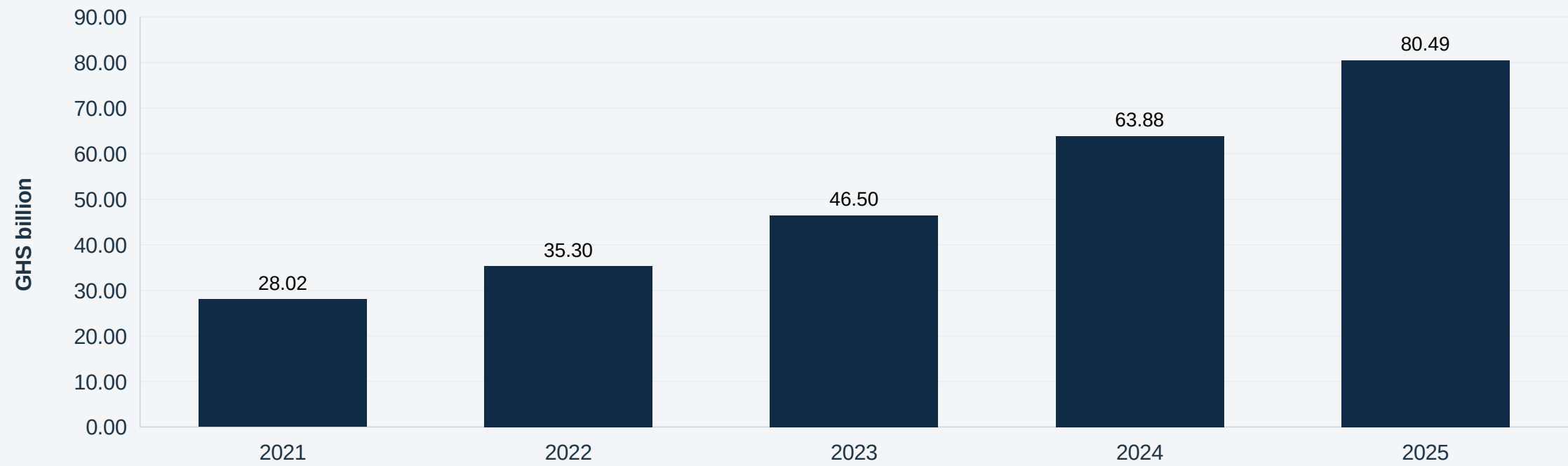
Table 4. Non-realised yield-versus-trailing-inflation diagnostics

Date	Bill diagnostic (%)	Deposit diagnostic (%)	Measurement warning
2024-12	3.16	-10.76	Quote versus trailing CPI; not earned return
2025-06	0.94	-2.79	Quote versus trailing CPI; not earned return
2025-12	5.40	4.85	Quote versus trailing CPI; not earned return
2026-03	1.62	6.08	Quote versus trailing CPI; not earned return
2026-06	-0.03	4.94	Quote versus trailing CPI; not earned return

Private-pension AUM increased to GHS 80.49 billion in 2025

NPRA private schemes; end-year asset stocks, not investment performance.

Figure 2. Private-pension assets under management



AUM growth includes external contributions, benefit payments, expenses, transfers and valuation effects.

A larger fund stock is not the return earned by its members

Year-end stock comparisons and matched calendar-year CPI answer a balance-sheet question.

Table 5. Three distinct measures

Measure	Result or definition	Interpretation
Nominal private AUM growth	26.00%	Aggregate stock change, 2024–2025
CPI-deflated private AUM growth	19.56%	Stock purchasing power; not portfolio return
Time-weighted investment return	Linked flow-adjusted subperiod returns	Not computable from annual AUM alone
Member money-weighted return	IRR of member’s dated net cash flows	Needs contribution, withdrawal and fee records

Sources: BoG (2026; retained inputs); NPRA (2025 report); IDER calculations. [S01](#), [S02](#).

Government securities remained the largest reported asset class

NPRA’s aggregate allocation categories; no look-through into pooled funds or security maturities.

Table 6. Private-pension asset allocation

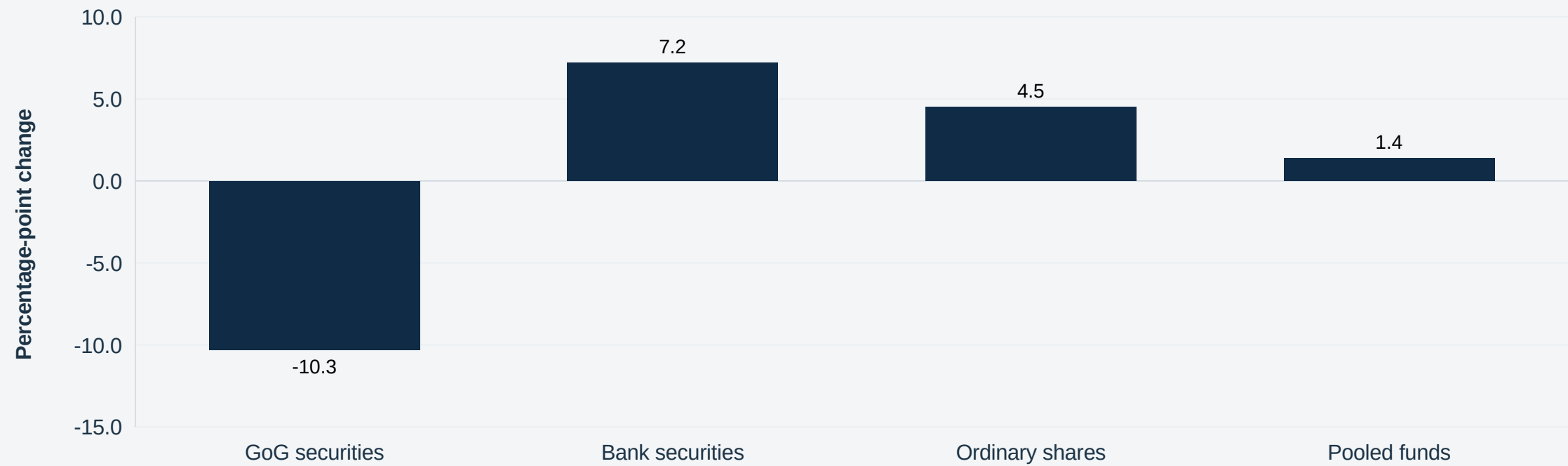
Asset class	2024 (%)	2025 (%)	Change (pp)
Government of Ghana securities	72.9	62.6	-10.3
Local government securities	0.9	1.1	+0.2
Corporate debt securities	1.3	1.4	+0.1
Bank securities	8.6	15.8	+7.2
Collective investment schemes	3.5	4.9	+1.4
Ordinary shares	5.7	10.2	+4.5
Alternative investments	1.1	1.2	+0.1
Cash	6.0	2.8	-3.2

GoG securities are not synonymous with Treasury bills; bank securities are not automatically deposits.

The share shift is measurable; its maturity-risk effect is not

End-2024 to end-2025; percentage-point changes in reported private-pension allocation.

Figure 3. Allocation-share changes



A lower government-security share can coexist with more holdings

Derived amounts = reported allocation share × total private AUM; source-rounding uncertainty retained.

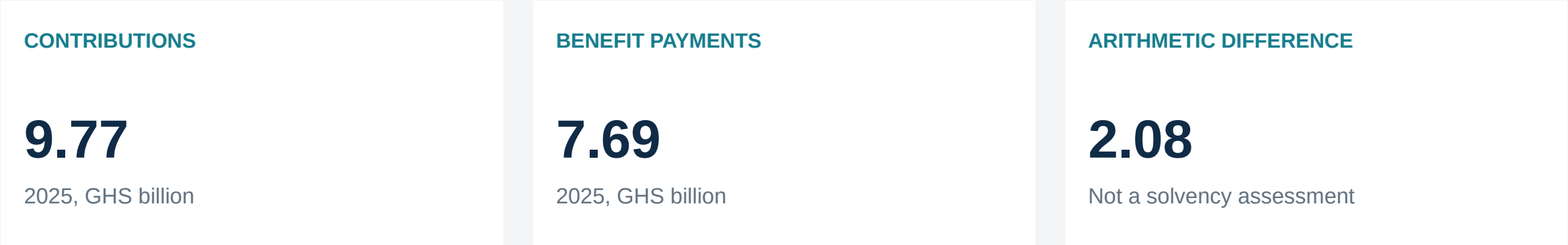
Table 7. Derived holdings from rounded source inputs

Asset class	2024 (GHS bn)	2025 (GHS bn)	Growth (%)
Government of Ghana securities	46.57	50.39	8.2
Bank securities	5.49	12.72	131.5
Ordinary shares	3.64	8.21	125.5
Collective investment schemes	2.24	3.94	76.4

Derived holdings are not directly reported security-register balances. No maturity or valuation attribution is identified.

A positive contribution–benefit balance is not actuarial solvency

NPRA’s 2025 BNSSS cash-flow figures; GHS billion.



Assess cash coverage and long-term benefit financing separately. The asset portfolio, future contributions, expenses, benefit rules and longevity assumptions are all needed for a funding assessment.

The GHS 2.08 bn difference excludes other expenses, asset cash flows and changes in future benefit obligations.

Life and non-life insurers require different cash-flow tests

Financial Stability Review 2024; approximate investment assets and a material reporting caveat.

LIFE INVESTMENT ASSETS

≈6.7 bn

GHS; 2024 review

NON-LIFE INVESTMENTS

≈3.1 bn

GHS; 2024 review

REPORTING COVERAGE

Limited

Audited submissions during transition

Neither total establishes the duration gap, guarantee burden or liquid resources of an individual insurer. Those require product-level liabilities, asset cash flows and policyholder behaviour.

Insurance amounts are dated 2024 observations, not September 2026 sector totals or audited institution-level risk estimates.

A published real return needs its own inflation convention

NPRA reports BNSSS nominal and real returns; the deflator basis is not reproduced by this report.

Table 8. Return-convention reconciliation

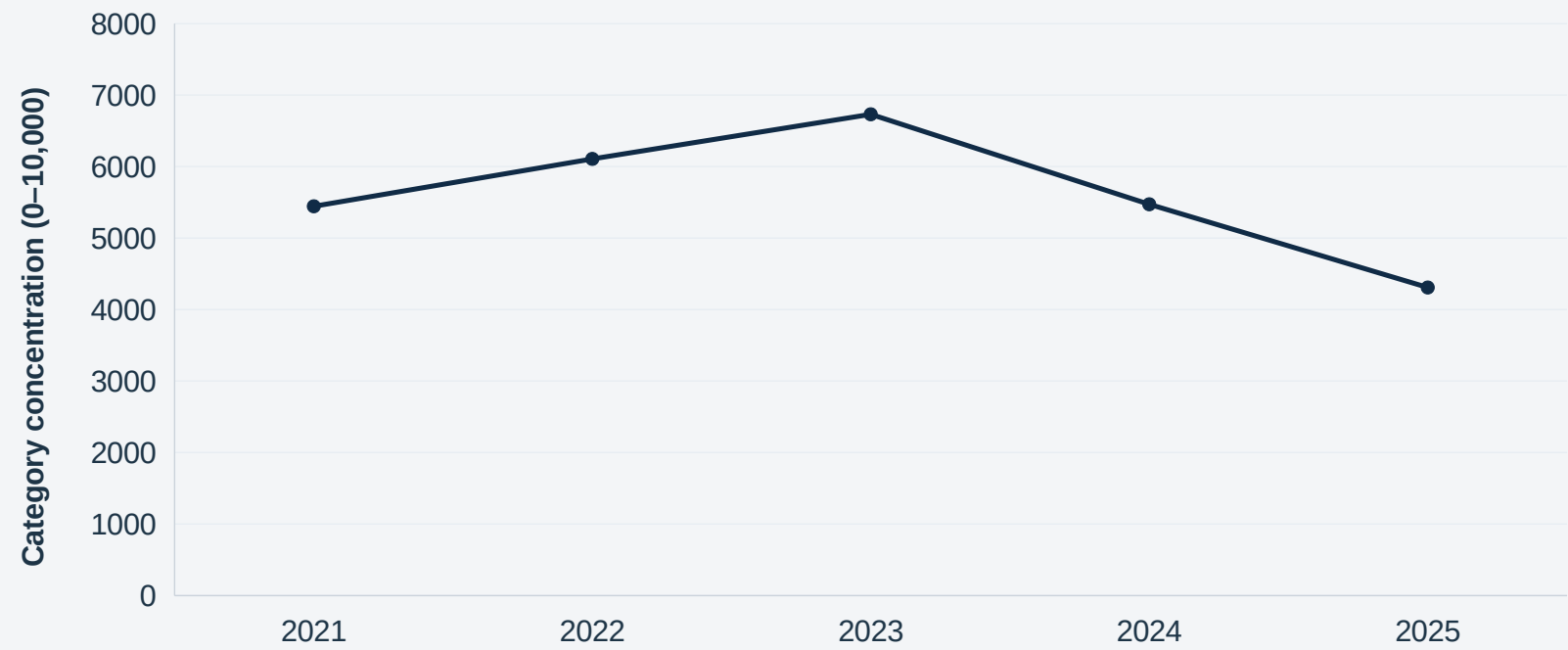
Record	Value	Treatment
NPRA-reported 2025 nominal return	23.8%	Published BNSSS statistic; methodology not re-estimated
NPRA-reported 2025 real return	8.0%	Retain as source-defined
Exact-ratio implied deflator	14.63%	$1.238 / 1.08 - 1$; conditional diagnostic
BoG December 2025 CPI y/y	5.39%	Different basis; not substituted silently

The implied deflator is an algebraic diagnostic, not a correction to NPRA's published return or an inflation estimate.

The reported asset mix became less concentrated in 2025

Eight published asset classes; the index describes category weights, not issuer risk or investment performance.

Figure 4. Concentration across the eight reported pension asset classes



2025 category mix

HHI: 4,308.9

Effective categories: 2.32

A pooled-fund category can conceal different underlying risks.

HHI = sum of squared percentage shares. Pooled-fund look-through and instrument maturities are unavailable.

AUM expansion and asset-mix changes reconcile to every holding

Symmetric midpoint decomposition, end-2024 to end-2025. GHS billion; derived from rounded NPRA inputs.

Table 9. Derived holding changes and exact scale–mix components

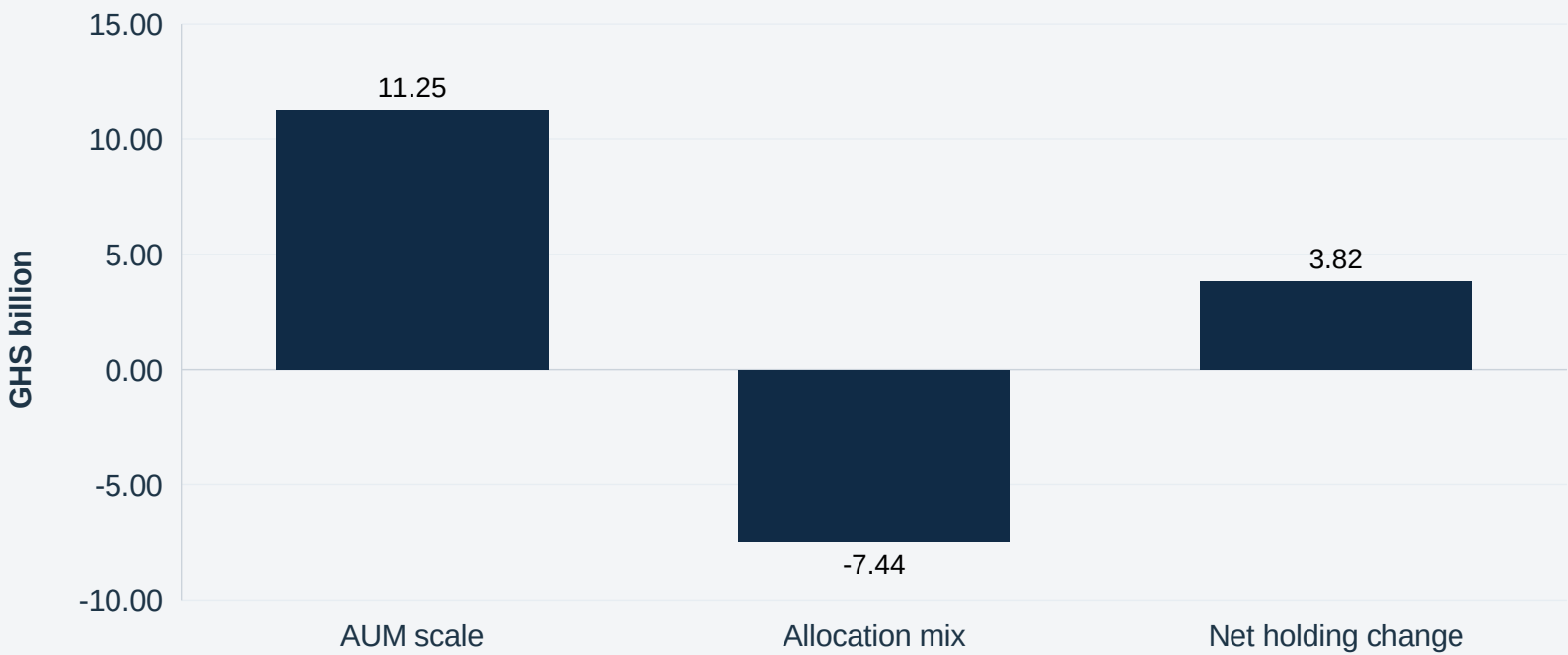
Asset category	2025 holding	Scale component	Mix component	Total change
GoG securities	50.39	+11.25	-7.44	+3.82
Local government	0.89	+0.17	+0.14	+0.31
Corporate debt	1.13	+0.22	+0.07	+0.30
Bank securities	12.72	+2.03	+5.20	+7.22
Collective schemes	3.94	+0.70	+1.01	+1.71
Ordinary shares	8.21	+1.32	+3.25	+4.57
Alternatives	0.97	+0.19	+0.07	+0.26
Cash	2.25	+0.73	-2.31	-1.58

Scale and mix are accounting components, not net purchases, investment returns or causal effects.

A smaller share is not evidence of a net sale

The GoG example separates a positive AUM-scale component from a negative mix component.

Figure 5. GoG holding change: exact scale and mix accounting



Separate two measures

GoG holdings: +GHS 3.82 bn

All-category mix movement: 13.5 pp

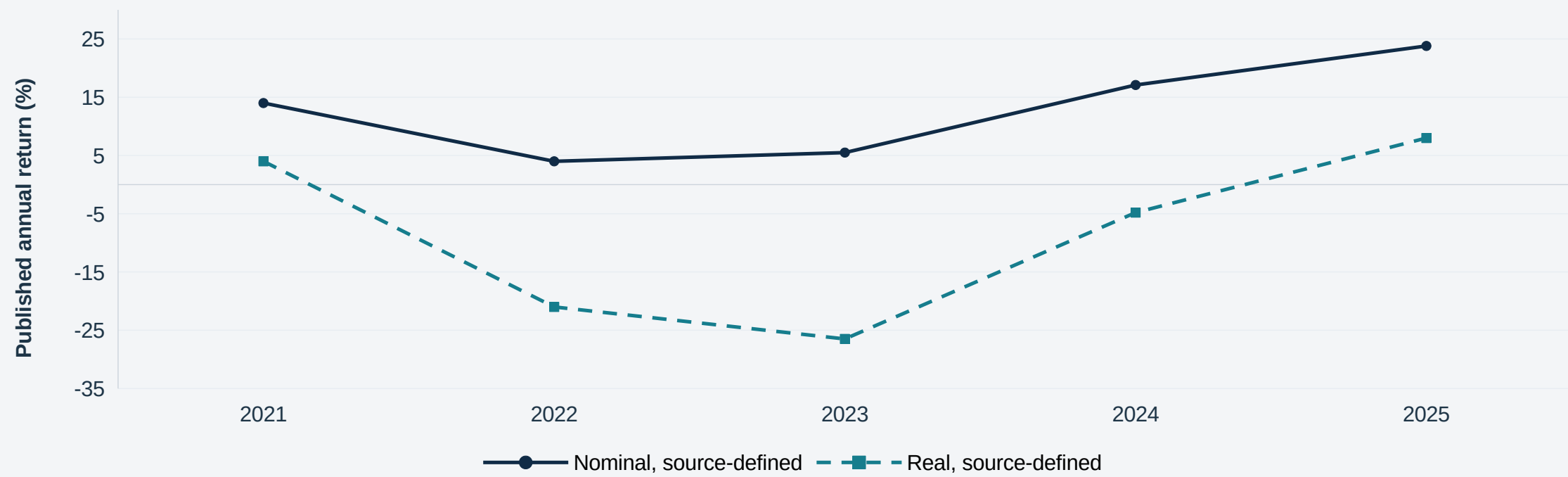
Neither measures net securities purchases.

Total variation in allocation weights is not portfolio transaction turnover. Rounded components may not sum at displayed precision.

Source-defined nominal and real returns diverged in several years

NPRA Figure 6, 2021–2025. These BNSSS statistics are not private-pension AUM growth or member-level estimates.

Figure 6. Published nominal and real BNSSS returns



Published return conventions are retained. The inflation basis, fee treatment and flow adjustment have not been independently reconstructed.

Contribution coverage improved from the 2021 shortfall

Published chart amounts, GHS billion. Contributions divided by benefits is a cash-flow ratio, not actuarial funding.

Table 10. Contribution and benefit-payment coverage

Year	Contributions	Benefits	Cash difference	Coverage ratio
2021	3.38	3.63	-0.25	0.93×
2022	4.36	4.17	+0.19	1.05×
2023	6.01	5.46	+0.55	1.10×
2024 *	8.80	6.46	+2.34	1.36×
2025	9.77	7.69	+2.08	1.27×

2024 uses Figure 11 (8.80 / 6.46); adjacent prose gives 8.7 / 6.5. The discrepancy is retained, not silently corrected.

Coupon, yield, income and total return are different quantities

Specify the cash flows, valuation basis, period and costs before comparing products.

Table 11. Measures for a comparable return record

Measure	Definition	Critical distinction
Coupon income	Contractual payment / face value	Not purchase-price yield
Yield to maturity	Cash-flow discount rate at the quoted price	Assumes specified cash flows; not realised total return
Holding-period return	Income + value change, divided by starting value	Sales, defaults and transaction costs matter
Time-weighted / money-weighted	Flow-neutral linked returns / dated cash-flow IRR	Fund performance versus investor experience
Real net return	Net nominal growth factor / matched CPI factor –1	Not simply headline yield less annual inflation

Net real return depends on both cost timing and inflation

Worked one-year illustration: 10% gross total return, 1% year-end asset fee, 8% inflation.

$$\text{Real net return} = [(1 + \text{gross return}) \times (1 - \text{fee})] / (1 + \text{inflation}) - 1$$

GHS 100.00 → GHS 110.00 before fee → GHS 108.90 after fee

Opening-price purchasing power: $108.90 / 1.08 = \text{GHS } 100.83$

Real net return: +0.83%. The 1% fee is an assumption, not a Ghanaian statutory or market tariff.

Four declared return–inflation combinations test purchasing power

Annual effective gross total returns; 1% fee on year-end gross assets; no tax or default.

Table 12. Declared annual scenario inputs

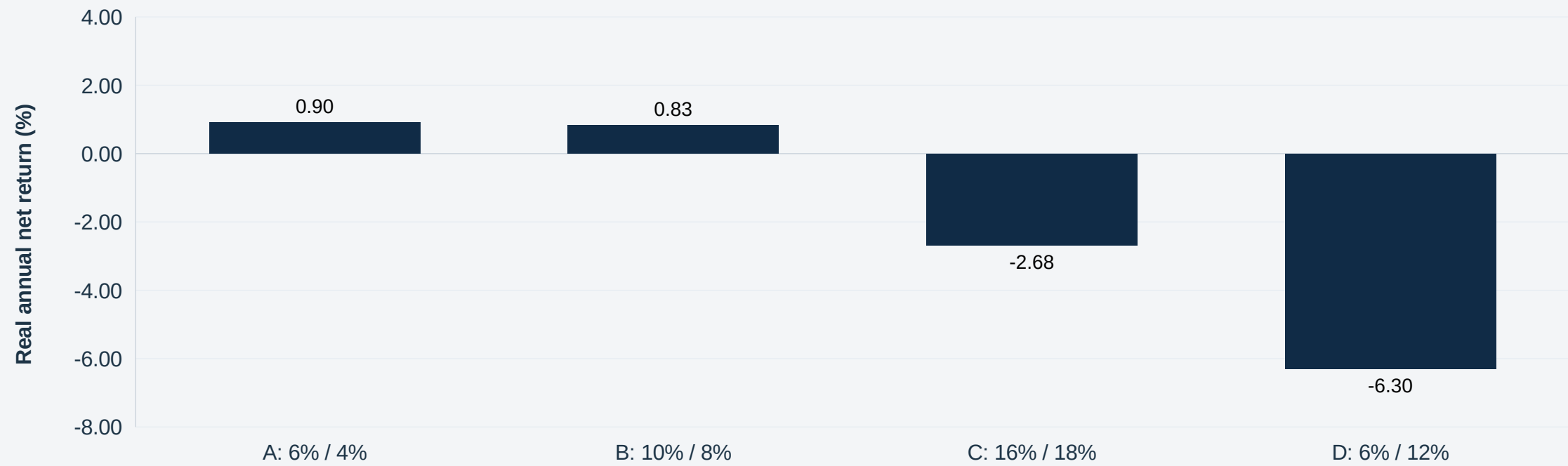
Scenario	Gross return (%)	Inflation (%)	Year-end fee (%)
A: lower return / lower inflation	6	4	1
B: intermediate return / inflation	10	8	1
C: higher return / higher inflation	16	18	1
D: low return / persistent inflation	6	12	1

Scenarios have no assigned probabilities and are not forecasts of the Bank of Ghana's policy rate or any product return.

Higher nominal returns need not deliver higher real returns

One-year net results after the stated fee and matched inflation; all values are modelled.

Figure 7. Real net return under the four assumed combinations



Real-return scenarios are conditional calculations. No frequency, confidence interval or probability of occurrence is estimated.

The return needed to preserve purchasing power rises with inflation

1% year-end asset fee; annual effective returns; zero tax and no other costs.

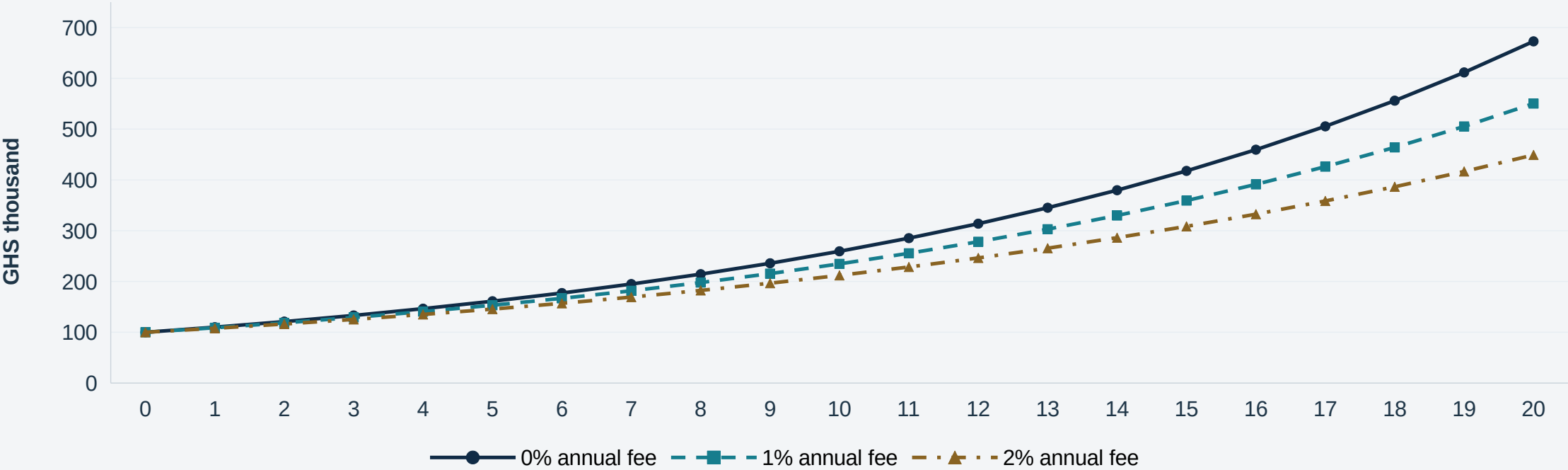
Table 13. Real net return matrix and gross break-even rate

Assumed gross return	4% inflation	8% inflation	12% inflation	18% inflation
6%	+0.90%	-2.83%	-6.30%	-11.07%
10%	+4.71%	+0.83%	-2.77%	-7.71%
16%	+10.42%	+6.33%	+2.54%	-2.68%
Gross break-even	5.05%	9.09%	13.13%	19.19%

A recurring fee has a cumulative effect on the terminal balance

GHS 100,000 initially; 10% gross annual return for 20 years; no contributions, withdrawals or tax.

Figure 8. Terminal-value paths under alternative assumed fees



Fee rates and the constant return are hypothetical. This is a cost-sensitivity illustration, not a product comparison.

The new purchase yield changes cash income on a fixed principal

Simple annual income rates on GHS 100,000; principal neither consumed nor compounded.

Table 14. Cash income and capital arithmetic

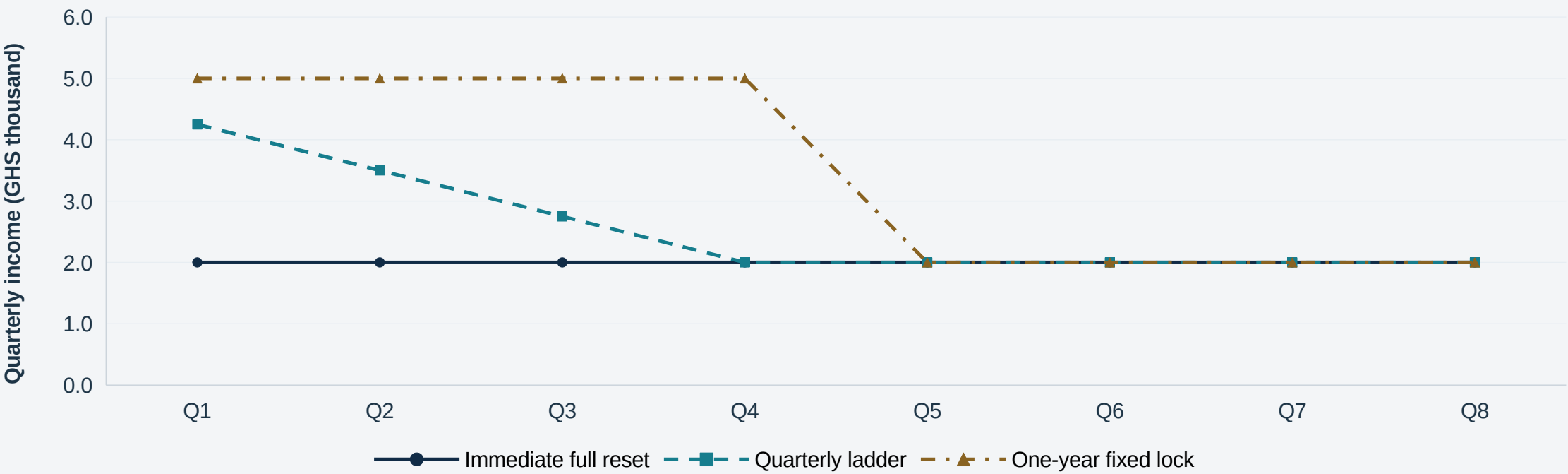
Illustrative case	Principal (GHS)	Annual income rate	Gross annual income
Original income	100,000	20%	20,000
Full repricing at maturity	100,000	8%	8,000
Capital needed for old income	250,000	8%	20,000
Change at unchanged principal	0 -12 pp		-12,000 (-60%)

Source: IDER calculations; stated hypothetical assumptions.

A ladder can delay—but does not eliminate—lower reinvestment income

Quarterly cash coupons; old 20% versus new 8%; four equal principal tranches; no income reinvestment.

Figure 9. Quarterly cash income under three reset schedules



Quarter 1 resets 25% at its start; all four tranches have reset by Quarter 4. All portfolios pay 8% by Year 2.

Value the existing cash flows before evaluating reinvestment

Stylised five-year annual-coupon bond; face 100, coupon 12, base discount yield 12%.

Table 15. Fixed-cash-flow bond specification

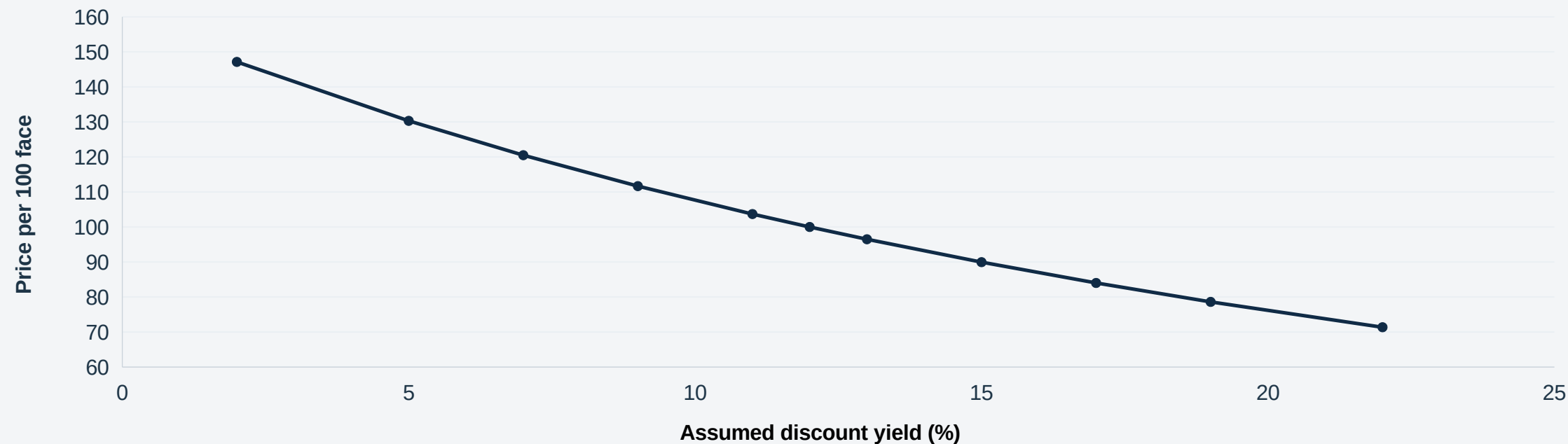
Parameter	Assumption	Reason for disclosure
Principal and coupon	100 face; 12 each year	Coupon is not the purchase-price yield
Maturity / payment timing	Five years; year-end coupons	Cash-flow dates drive sensitivity
Base curve	Flat 12%; annual compounding	Hypothetical, not Ghana’s observed term structure
Rate shocks	Exact repricing over 2%–22% yields	No linear approximation substituted
Excluded effects	Default, options, costs and taxes	Price results are conditional on payment

Source: IDER calculations; stated hypothetical assumptions.

Falling discount yields raise the value of fixed cash flows

Price per 100 face of the stated five-year 12% coupon bond; exact present values.

Figure 10. Bond price under alternative assumed discount yields



This is a deterministic price–yield curve. It is not a fitted relationship or a forecast of Ghanaian bond prices.

Duration is local; convexity improves a large-shock approximation

Exact price changes compared with first- and second-order approximations around 12%.

Table 16. Exact and approximate bond-price changes

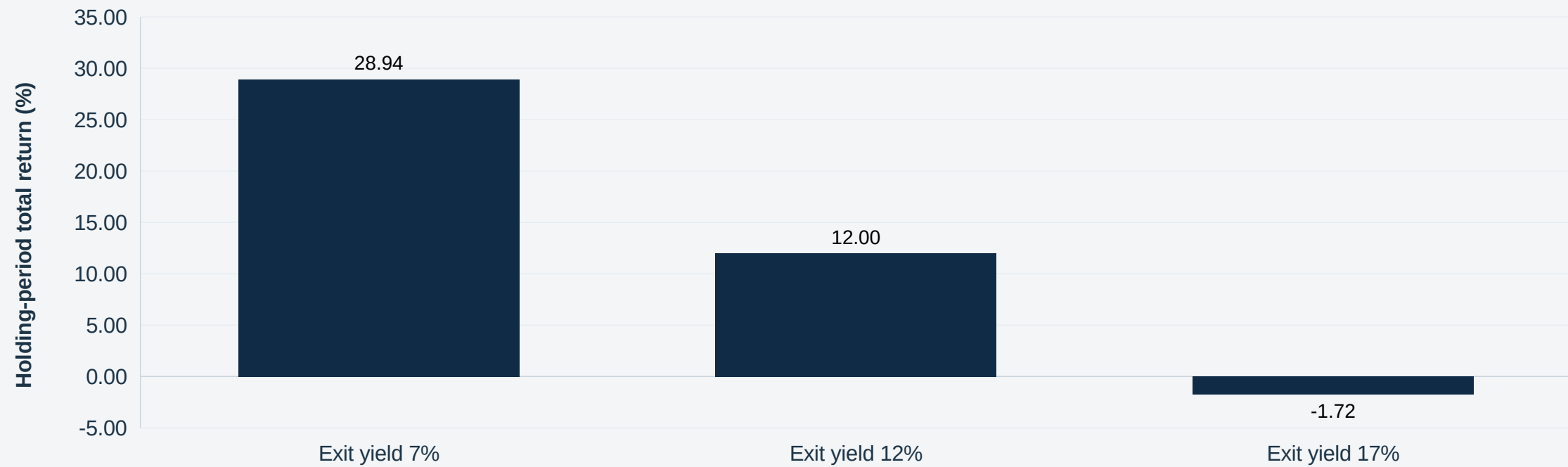
New yield	Exact change (%)	Duration only (%)	Duration + convexity (%)
7%	20.50	18.02	20.26
9%	11.67	10.81	11.62
12%	0.00	0.00	0.00
15%	-10.06	-10.81	-10.01
17%	-16.00	-18.02	-15.79

Modified duration=3.605 years; convexity=17.860 years².

The same coupon can accompany very different holding-period returns

Buy at 100; receive 12 after one year; sell the remaining four-year bond immediately after the coupon.

Figure 11. One-year holding-period return



No coupon is counted twice. The exit price is ex-coupon; costs, tax and default are excluded.

A funding test must revalue both sides of the balance sheet

Stylised funded pool; GHS million. This is not a valuation of SSNIT or an actual insurer.

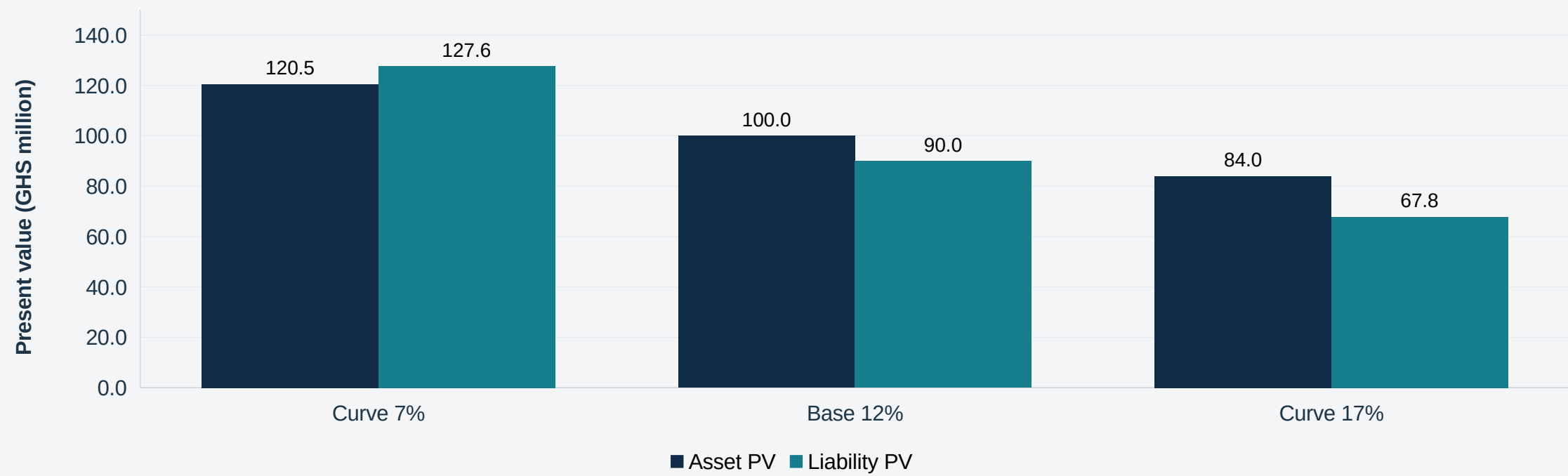
Table 17. Nominal funded-pool assumptions

Component	Specification	Base value / sensitivity
Assets	Five-year 12% annual-coupon bond	PV 100.00; modified duration 3.605 years
Liabilities	Twenty fixed year-end benefit payments	PV 90.00; annual payment 12.049
Liability duration	Same 12% discount convention	6.268 years
Base economic position	Asset PV less liability PV	Surplus 10.00; funding ratio 111.1%
Scope exclusions	No mortality, indexation, costs or new business	Not a statutory funding or solvency ratio

An asset gain can be smaller than the increase in obligations

The 20-year fixed nominal liability schedule is more rate-sensitive than the five-year asset.

Figure 12. Revaluation of assets and fixed nominal liabilities

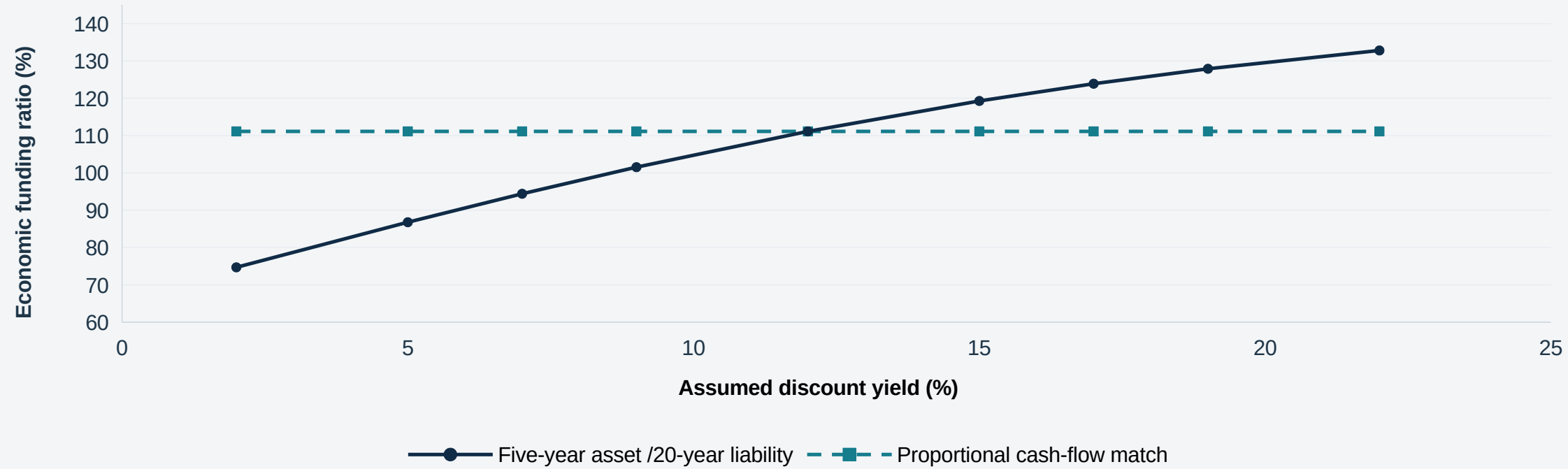


Modelled present values, GHS million; all cash flows held fixed. Falling yields are not unconditionally beneficial.

The mismatch changes the funding ratio—not just the asset value

Economic assets / liabilities under parallel curve shifts; fixed nominal benefits.

Figure 13. Economic funding under mismatched and matched schedules



Cash-flow matching preserves the ratio only under the specified common curve and unchanged, default-free payment schedules.

Duration matching is not the same as matching every payment

A first-order hedge is local; actual payment coverage depends on dates, curves and cash-flow uncertainty.

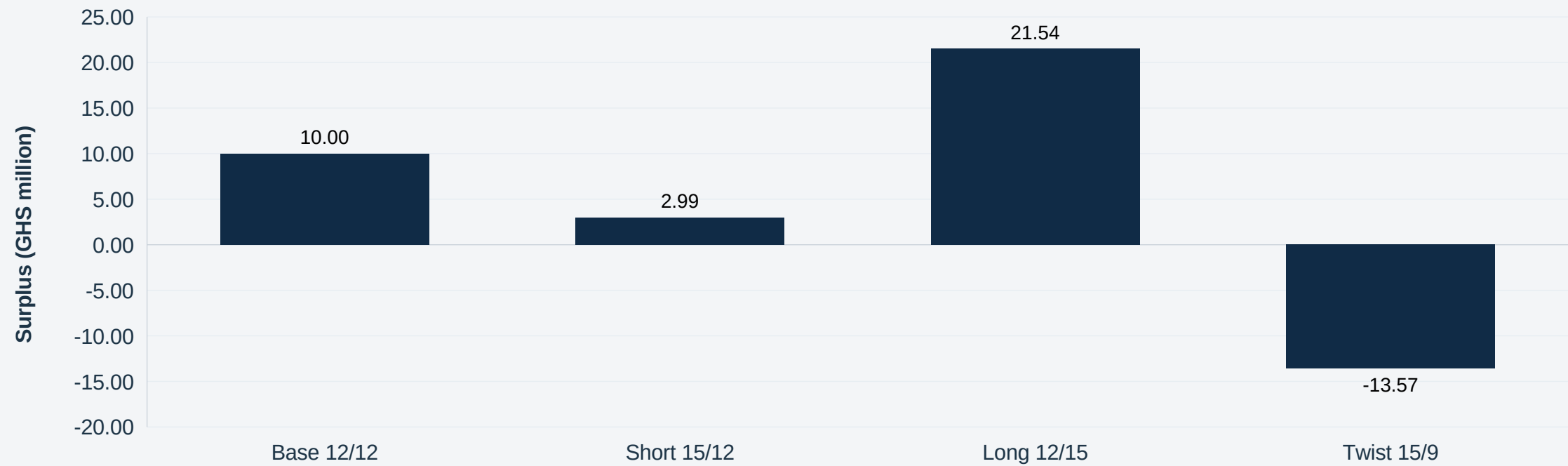
Table 18. Matching concepts and limitations

Approach	What it aligns	What remains
Maturity ladder	Dates of principal becoming available	Reinvestment yield and benefit-payment mismatch
Duration / PV01 match	First-order value change for a defined shock	Curve twists, convexity and cash-flow changes
Cash-flow match	Asset receipts against liability payments	Default, indexation, optionality and implementation
Inflation-aware ALM	Nominal assets with indexed benefit exposure	Inflation basis, availability and pricing of protection
Liquidity overlay	Near-term payments and encumbered assets	Stress sale prices, behaviour and collateral calls

A single duration number can conceal long-end exposure

Piecewise spot-curve shocks; annual maturities 1–5 versus 6–20; all cash flows fixed.

Figure 14. Economic surplus under non-parallel curve assumptions



The long-end-only shock leaves the five-year asset unchanged but changes the twenty-year liability PV.

Inflation can increase liabilities even when discount yields rise

Twenty year-end payments; first benefit fixed; later payments grow at the assumed inflation rate.

Table 19. Indexed liability PV under joint assumptions, GHS million

Annual benefit escalation	Discount 7%	Discount 12%	Discount 17%
4%	100.72	67.29	48.50
8%	142.44	90.00	61.78
12%	207.97	124.39	81.15

The liability amount and its discount rate must be stressed separately. A lower measured discount-value ratio does not erase higher future benefit payments.

First benefit is calibrated so liability PV=90 at an 8% indexation rate and a 12% discount yield. Not a statutory indexation rule.

The interest-rate and inflation combination changes the funding result

Nominal asset versus indexed-benefit model; GHS million; each row is an assumed state.

Table 20. Joint indexed-liability funding scenarios

Curve / escalation	Asset PV	Liability PV	Funding ratio (%)
7% / 4%	120.50	100.72	119.6
12% / 8%	100.00	90.00	111.1
17% / 12%	84.00	81.15	103.5
7% / 12%	120.50	207.97	57.9

This grid uses the indexed-liability model, not the fixed nominal-benefit model on the preceding funding chart.

Reinvestment income can fall below a fixed crediting commitment

Hypothetical 100 million reserve; 8 million annual guarantee credit and 1 million expenses.

Table 21. Illustrative reinvestment-income budget

Gross income rate	Gross income	Guarantee + expenses	Income margin
6%	6.0	9.0	-3.0
10%	10.0	9.0	+1.0
16%	16.0	9.0	+7.0

An income margin is not insurer profit, IFRS 17 service result, distributable surplus or a regulatory solvency measure.

A solvent-looking balance sheet can still face a cash shortfall

Assumed near-term cash receipts and payments; no institution-specific portfolio is being valued.

Table 22. Short-horizon liquidity arithmetic, GHS million

Cash item	Amount	Interpretation
Opening available cash	10.00	Unencumbered cash only
Maturities + collected net premiums	8.00	5.00 principal +3.00 already collectible receipts
Cash claims due	20.00	Payment timing drives the stress
Cash shortfall	2.00	Before financing or asset disposal
Face sold at price 84.00	2.381	Loss relative to par: 0.381

Only cash actually collectible within the stress window counts; sale proceeds depend on market depth and encumbrance.

A common-rate hedge does not remove credit-spread or default risk

Separate asset-specific stress from changes in the liability discount curve.

Table 23. Separate spread and loss stress examples

Scenario	Asset PV	Liability PV	Surplus
Base	100.00	90.00	10.00
Asset spread +300 bp; liability curve unchanged	89.94	90.00	-0.06
20% loss on 10% of assets; no rate move	98.00	90.00	8.00

Economic ALM, accounting results and capital requirements differ

Do not label a simplified discounted-cash-flow calculation as IFRS 17 or regulatory solvency.

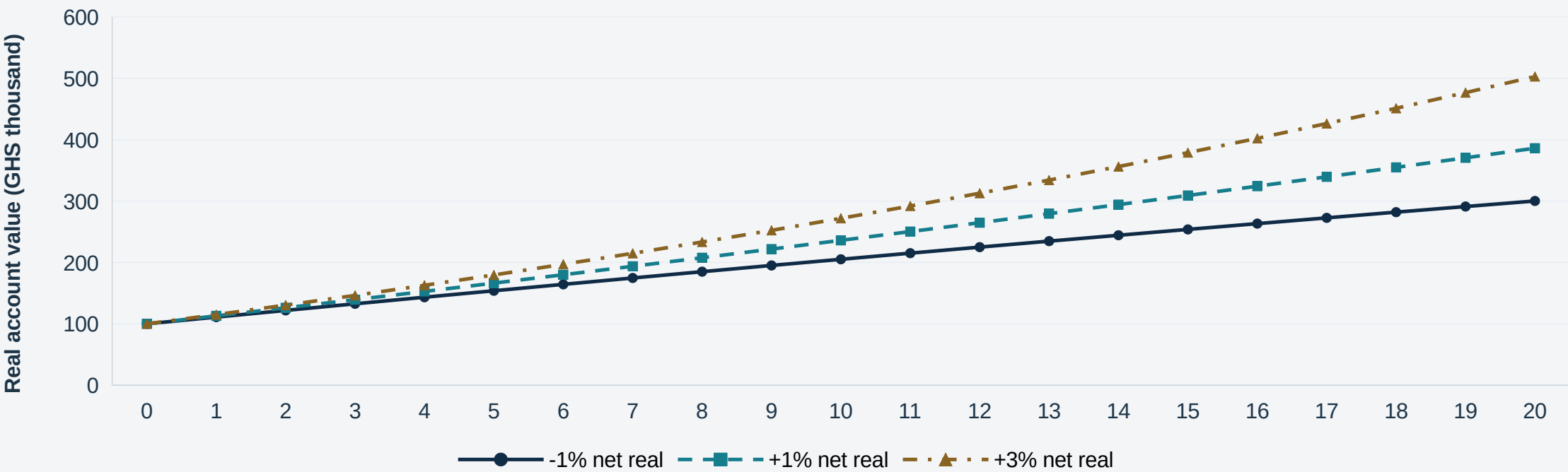
Table 24. Three measurement frameworks

Framework	Question	Not interchangeable with
Economic ALM	How do asset and liability values respond together?	Accounting equity or regulatory capital
IFRS 17 reporting	How are insurance contracts, service and finance results measured?	A simple discounted benefit annuity
Prudential solvency	Are eligible resources sufficient under applicable rules?	The report's asset PV / liability PV ratio
Cash liquidity	Can obligations be paid on their due dates?	Positive accounting earnings or economic surplus

Small differences in net real return compound over a working life

Initial 100,000 plus 12,000 at each year end for 20 years; values in constant purchasing-power GHS.

Figure 15. Accumulation under assumed net real returns



Contributions are fixed in real terms and therefore require nominal indexation. No mortality, tax or return uncertainty is modelled.

Longer payment horizons require a lower annual drawdown

GHS 1 million real capital; equal year-end real withdrawals; deterministic net real returns.

Table 25. Constant-real annual withdrawals from GHS 1 million

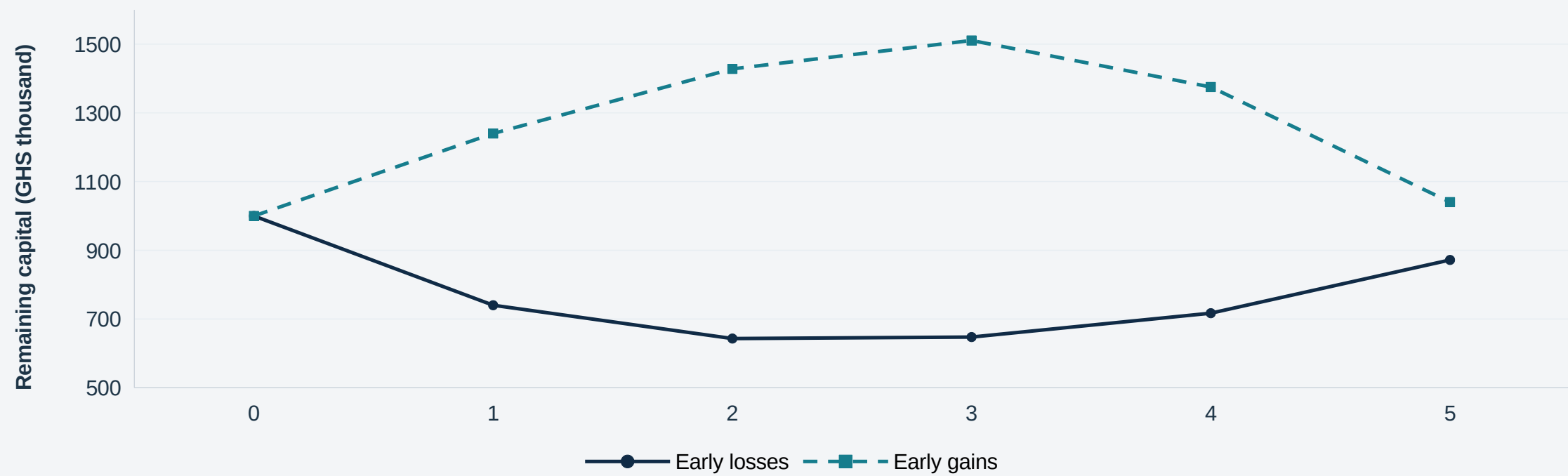
Net real return	20-year horizon (GHS)	30-year horizon (GHS)
-2%	40,170	24,003
0%	50,000	33,333
+2%	61,157	44,650
+4%	73,582	57,830

Amounts exhaust capital at the stated horizon. They are not safe withdrawal rates or annuity quotations.

With withdrawals, the order of returns changes the outcome

Same five net returns in reverse order; initial GHS 1 million; 60,000 withdrawn at each year end.

Figure 16. Capital remaining under reversed return sequences

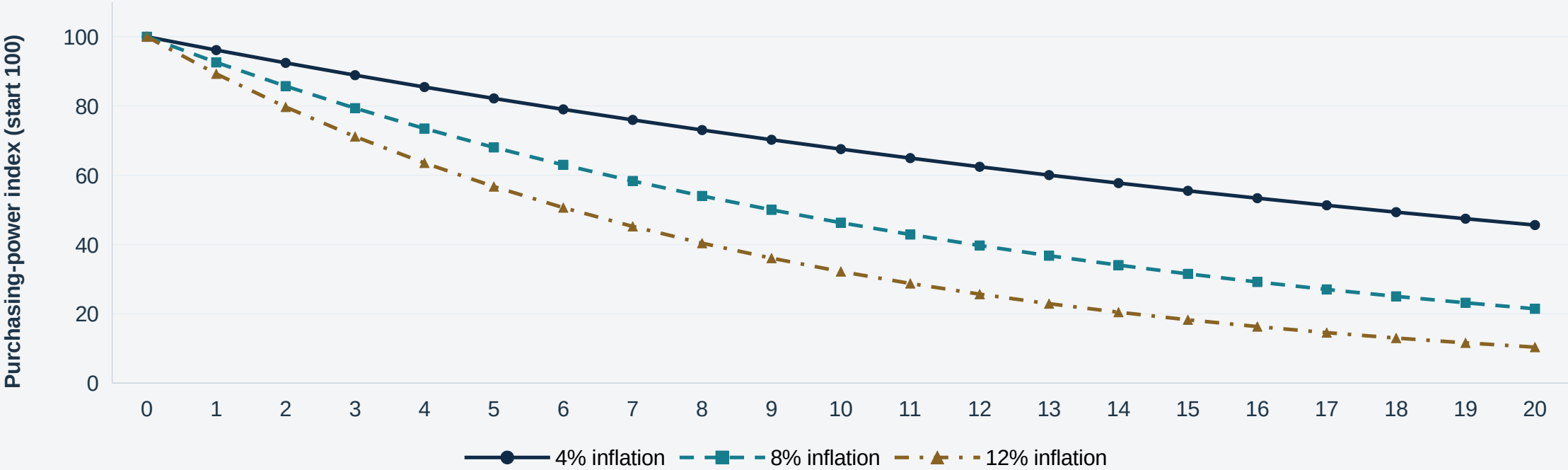


Inflation is set to zero only to isolate sequence risk. The return sequence is hypothetical and has no assigned probability.

A fixed nominal payment buys progressively less under inflation

Purchasing-power index of an unchanged nominal payment; initial value=100.

Figure 17. Real value of a fixed nominal payment



These paths assume constant inflation and no benefit indexation. They do not describe the rules of a named pension scheme.

Compare the full income contract—not the advertised percentage

A practical information request for savers, retirees and member representatives.

Table 26. Comparable saving and retirement-income record

Field	Information to obtain	Reason
Income terms	Fixed / floating rate, reset date and payment frequency	Separates current income from reinvestment risk
Access to capital	Maturity, notice, surrender terms and early-exit charges	Identifies forced-sale or liquidity exposure
Net return	All charges, actual tax treatment and quote convention	Enables like-for-like cash-flow comparison
Protection	Issuer, guarantee terms and applicable coverage	A higher quoted yield is not protection
Real spending	Benefit indexation and household budget inflation	Nominal capital preservation may not preserve welfare

Separate member accumulation, benefit financing and liquidity

Apply the diagnostics to the actual scheme type and member population.

Members and cohorts

Track net returns, actual contributions and inflation-adjusted balances by retirement horizon. Separate cohort outcomes from aggregate AUM growth.

Benefit financing

Reconcile asset cash flows with benefit dates, indexation and expenses. Evaluate both economic value and projected cash coverage.

Governance and mandate

Document reset concentrations, issuer exposure and model assumptions. Confirm current investment rules and scheme-specific limits before action.

Segment guaranteed, participating, linked and non-life liabilities

The same asset can serve different purposes in different liability portfolios.

Table 27. Product-segment ALM diagnostics

Liability segment	Core sensitivity	Required behaviour / cash-flow test
Guaranteed life / annuity	Long-duration promise versus reinvestment yield	Guarantee margin; longevity; surrender stress
Participating business	Asset return versus bonus and guarantee rules	Contractual discretion and policyholder expectations
Unit-linked products	Linked asset values plus residual guarantees / expenses	Lapses, charges, options and basis risk
Short-tail non-life	Payment liquidity and claim inflation	Claims timing, reinsurance collection and sales
Long-tail non-life	Reserve duration and escalating claim costs	Settlement delays and liability discount basis

The evidence supports different questions for each audience

These are analytical uses, not claims that institutions have adopted the framework.

Table 28. Audience-specific questions

Audience	Decision-relevant diagnostic	Boundary
MoF / BoG / regulators	Investor maturity exposure, reinvestment and funding channels	No policy-rate recommendation from a scenario
Fund / asset managers	Net returns, duration, reset buckets and liability benchmark	No single optimal portfolio inferred
Banks / businesses / MSMEs	Deposit income, reserve liquidity and pension cash continuity	Institutional average rates are not quotations
DFIs / institutional investors	Cash-flow fit, credit quality and instrument additionality	Long maturity is not automatically suitable
Retirees / associations	Net usable income and purchasing-power exposure	No personalised withdrawal or product advice

No single instrument removes every interest-rate risk

Evaluate alternatives against the actual liability, liquidity and mandate constraints.

Table 29. Conditional alternatives and residual risks

Instrument / approach	Potential role	Residual risk or feasibility test
Short maturities	Near-term liquidity and limited price sensitivity	Frequent reinvestment at uncertain rates
Long fixed-rate cash flows	Nominal payment matching	Price loss on exit; credit and market depth
Maturity ladder	Disperse reset dates	Does not preserve the old yield indefinitely
Index-linked exposure	Address a specified inflation promise	Index basis, availability and valuation
Duration hedge / derivatives	Alter defined curve exposure	Mandate, collateral, counterparty and model risk

Every dashboard metric needs a horizon, owner and denominator

Proposed measurement controls; none is presented as an achieved result or a regulatory minimum.

Table 30. Auditable monitoring indicators

Metric	Definition and unit	Frequency / proposed owner
Reset exposure	Principal and coupons resetting in 3 /12 /24 months; % assets	Monthly; investment operations
Net income sensitivity	Stressed minus baseline 12-month cash income; GHS	Quarterly; ALM / treasury
Economic mismatch	Asset PV01 minus liability PV01; GHS per bp	Monthly; risk / actuarial team
Payment coverage	Available inflows / liabilities due by date	Weekly or monthly; liquidity desk
Real member outcome	IRR of CPI-deflated dated member flows; horizon stated	Quarterly; pension administrator
Data quality	≥98% mandatory field completion; exceptions disclosed	Each release; independent checker

Connect securities, liabilities, member flows and market vintages

Empty collection templates accompany the report; no private records have been invented.

Table 31. Minimum institution-specific data architecture

Block	Essential fields	Linkage / control
Assets	Issuer, currency, face, price, coupons, maturity, reset, options	Instrument ID; transaction / valuation date
Liabilities	Benefit / claim dates, indexation, guarantees, survival / settlement	Contract or liability cohort; assumption version
Member / investor flows	Contributions, withdrawals, units, charges and actual payment dates	Pseudonymous account; cash-flow ledger
Market inputs	Term curves, spreads, CPI and quote convention	Same-date source and vintage
Governance	Mandate, legal constraints, encumbrance and data permissions	Authorised access; reconciliation and exceptions

A deterministic stress test is not a causal policy estimate

Public aggregates support exposure diagnostics; identified effects require a different research design.

Completed here

Observed benchmark and asset-mix comparisons; exact cash-flow valuation; real-return, withdrawal and sensitivity calculations.

Not identified here

How much policy decisions caused a given institution's return, benefit change, solvency position or retirement-income outcome.

Requirements for estimation

Dated instrument and member panels; defensible shocks; baseline exposures; flow adjustment; dependence, selection and robustness checks.

Numerical precision does not remove assumption uncertainty

Stress multiple dimensions separately before imposing a joint scenario.

Table 32. Sensitivity design and scientific safeguards

Uncertainty	Test included or specified	Interpretation safeguard
Discount curve	Exact parallel repricing and two-bucket twists	No true market curve or shock probability claimed
Cash-flow assumptions	Fixed versus indexed benefits; reset timing	Actual optionality and survival not calibrated
Costs and purchasing power	Fee and inflation grids; exact compounding	No actual tax tariff or household CPI implied
Retirement drawdown	Two horizons and reversed return sequences	No estimated safe withdrawal / ruin probability
Institution and sample coverage	Different dates and missing liabilities disclosed	Aggregate holdings do not represent each investor

A 90-day programme can establish a reproducible ALM reporting base

The timetable begins after data-access, governance and participating-institution approvals.

Table 33. Proposed delivery schedule and release conditions

Period	Output	Acceptance condition
Days 0–15	Mandate, cash-flow perimeter and data dictionary	Institutional approval; assumptions and privacy rules documented
Days 16–30	Asset / liability / member data intake	Market and accounting values reconciled; gaps logged
Days 31–60	Valuation, reinvestment and drawdown stress analysis	Independent calculation checks; sensitivity and behaviour review
Days 61–90	Reviewed dashboard and research briefing	Only supported claims released; legal / actuarial sign-off scoped

The same account can grow while its investment return is negative

Hypothetical full year: 100 invested; +10% first half; 100 added at midyear; -10% second half.

Table 34. AUM growth versus flow-adjusted performance

Measure	Result	What it measures
Account asset growth	+89.00%	Closing versus opening assets; includes contributions
Time-weighted return	-1.00%	Linked investment subperiod returns
Money-weighted return	-7.29%	Investor return under the actual contribution timing
Modified Dietz approximation	-7.33%	Flow-weighted approximation; not identical to exact IRR

Year-end value is 189. No fee or tax. The example is a measurement test, not a reported Ghanaian member experience.

The liability book contains rate exposure beyond the asset maturity

Hypothetical nominal ALM book. Analytic sensitivities are checked against central finite differences.

Table 35. Two-bucket PV01 reconciliation

Maturity bucket	Asset PV01	Liability PV01	Surplus change for +1 bp
Years 1–5	36.05	10.76	-25.29
Years 6–20	0.00	45.65	+45.65
Total	36.05	56.41	+20.36

PV01 is reported in GHS thousand per basis point. These are two piecewise spot-curve buckets, not a complete market key-rate basis.

Solve for the point where the model's economic surplus reaches zero

Numerically solved conditional boundaries—not forecasts, regulatory thresholds or probabilities.

NOMINAL-BOOK YIELD BOUNDARY

8.56%

From a 12% base curve

INDEXED-BOOK ESCALATION

9.35%

Discount curve held at 12%

At each boundary, modelled asset and liability present values are equal. Stress capacity is specific to the assumed cash-flow schedules—not a single safe interest-rate level.

The two tests use separate liability models. Both start with asset PV 100 and liability PV 90; all other stated assumptions remain fixed.

Repricing exposure must be measured before estimating income loss

Scale illustration: GHS 80.49 bn AUM; retained bill-quote decline of 9.47 pp; assumed bill-like income exposure.

Table 36. Assumed reset exposure and conditional income changes

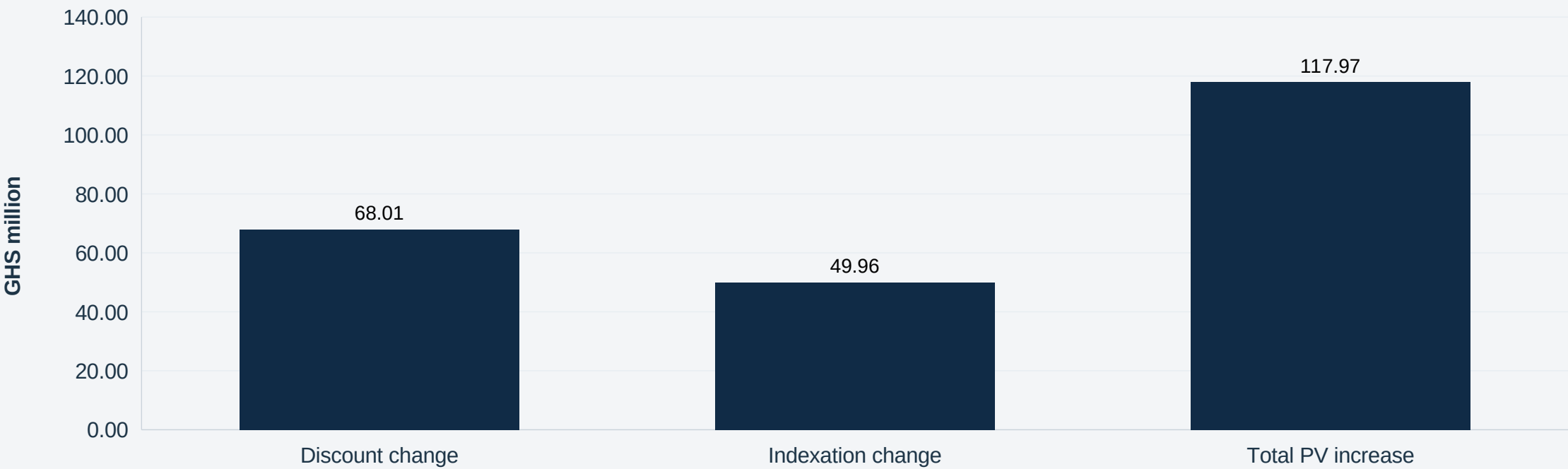
Assumed reset share	End-state annual change	First year: uniform resetting
10%	GHS -0.76 bn	GHS -0.38 bn
25%	GHS -1.91 bn	GHS -0.95 bn
50%	GHS -3.81 bn	GHS -1.91 bn

Reset fractions are assumptions. Government securities include bonds; the bill-rate change is not applied to the entire pension portfolio.

Discounting and indexation both contribute to the stressed liability

Indexed benefits: discount yield 12% → 7%; escalation 8% → 12%; first benefit unchanged.

Figure 18. Exact decomposition of the indexed-liability increase

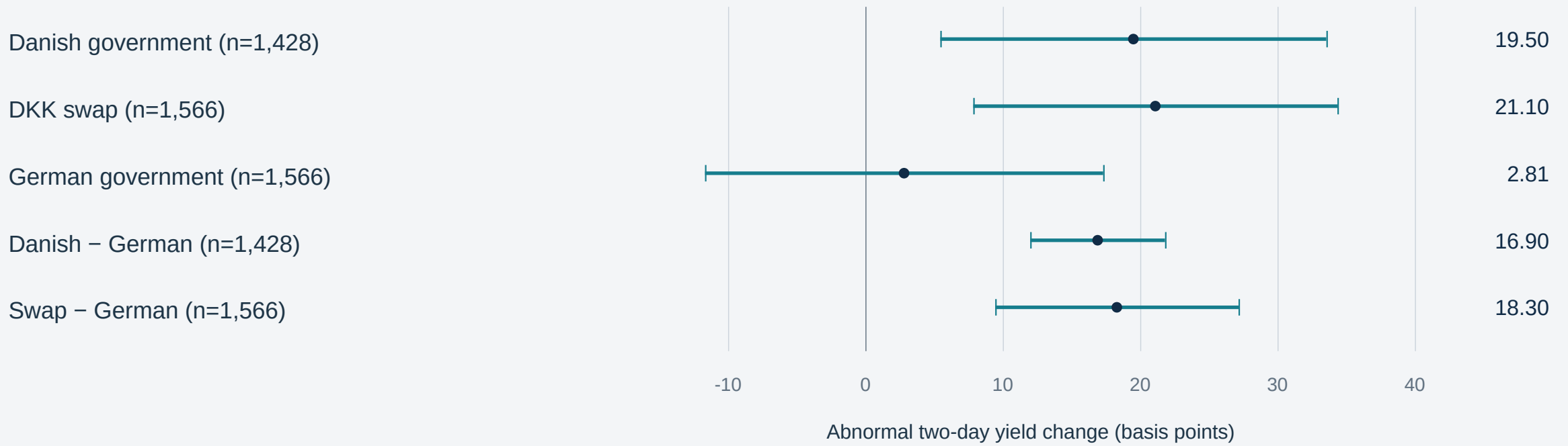


Components average the two possible factor orders. They are exact scenario accounting—not identified effects of monetary or inflation policy.

Pension discount rules can also move market yields

Denmark’s 2011 reform: all five published Table 5 estimates; daily sample 2008–2013.

Figure 19. Published abnormal yield changes after the Danish 2011 reform



Abnormal two-day changes; approximate pointwise intervals reconstructed from rounded t-statistics. Not Ghana estimates or a regression replication.

A rate decision, an information shock and a reset exposure differ

Specify the intervention and time ordering before deciding which variables belong in the model.

Before the shock

Fix instrument, maturity, guarantee, funding and member characteristics. Audit why exposures differed before the announcement.

At the announcement

Separate the unexpected rate component from central-bank information and concurrent fiscal or market news.

After exposure

Trace income, valuation and benefits separately. Do not treat post-shock reallocations or withdrawals as neutral controls.

An identified shock can isolate differential exposure—not a national effect

Specification for an authorised institution–instrument or member panel; not estimated on the aggregate snapshots.

$$\Delta_h Y(i,t) = \alpha(i,h) + \tau(t,h) + \beta(h)[S(t) \times E(i,t-1)] + \Gamma(h)X(i,t-1) + u(i,t,h)$$

Choose Y separately: net cash income, flow-adjusted return, economic surplus or member spending.
Use predetermined exposure and controls; test anticipation, concurrent shocks and common support.
Report horizon-specific estimates and uncertainty only after the identification and effective-sample checks pass.

No coefficient or standard error is fabricated. The common shock's main effect is absorbed by time effects.

Retain nonreporting institutions and exiting members in the frame

Representativeness, causal treatment selection and missing outcomes are distinct problems.

Table 37. Selection controls for actual institution and member data

Selection point	Record / procedure	Interpretation safeguard
Reporting availability	Complete institution roster; audited status; response timing	Do not analyse only surviving reporting funds
Member exit / transfer	Link old and new account IDs; date and value of transfer	Separate economic exit from missing follow-up
Unequal observed coverage	Pre-treatment frame variables; overlap and weight diagnostics	Weighting is conditional, not an automatic correction
Performance observation	Flow-adjusted returns; missing-code and price-quality flags	An absent return is not a measured zero
External validity	AUM and member counts by product, horizon and institution	Covered participants do not represent every saver

Source: IDER analytical framework; FSC Ghana (2024 review); CFA Institute (2020). [S03](#), [S11](#).

Bounded shares can be stress-tested without inventing missing returns

Assumed coverage and a 62.6% observed-share example; outcomes outside coverage may range from 0% to 100%.

Table 38. Conditional share bounds under assumed asset coverage

Assumed AUM coverage	Covered share example	Population share envelope
100%	62.6%	[62.55, 62.65]%
90%	62.6%	[56.30, 66.38]%
80%	62.6%	[50.04, 70.12]%
60%	62.6%	[37.53, 77.59]%

This is an assumed incomplete-coverage exercise, not an estimate of NPRA's response coverage or the missing insurance portfolios.

Stronger intelligence depends on a documented release decision

A staged protocol for data, identification, estimation and institutional review—not a promise of causal certainty.

Table 39. Conditions for empirical and causal release

Gate	Required evidence	Release outcome
Data and coverage	Dated flows; instrument and liability match; response frame	Descriptive results only when inputs reconcile
Identification	Defined surprise, exposure, timing and exclusion argument	Causal label withheld when assumptions fail
Estimation and inference	Independent events; clustered dependence; locked outcomes	Report intervals, sensitivity and weak precision
Decision use	Income, funding and liquidity considered together	No action inferred from an isolated yield coefficient
Independent review	Reproduction, subject-matter and actuarial review	Publish the level of claim the evidence supports

Source: IDER analytical framework; IAIS (2024); Jarociński and Karadi (2020); CFA Institute (2020). [S04](#), [S10](#), [S11](#).

Discount factors, duration and funding share one cash-flow basis

All model rates are decimals inside the code; reported rates are percentages.

Table 40. Valuation formulas and units

Quantity	Formula	Unit / limitation
Present value	$\sum CF(t) / (1+y)^t$	Same cash-flow currency
Modified duration	$\sum t \times CF(t) / (1+y)^{(t+1)} / PV$	Years; local curve sensitivity
Convexity	$\sum t(t+1) \times CF(t) / (1+y)^{(t+2)} / PV$	Years ² ; second-order sensitivity
PV01	$PV \times \text{modified duration} \times 0.0001$	Currency per basis point
Economic funding	$100 \times PV(\text{assets}) / PV(\text{liabilities})$	Percent; not statutory solvency
Surplus	$PV(\text{assets}) - PV(\text{liabilities})$	Currency; not immediate cash income

Match compounding, cash-flow dates and the inflation interval

Use one convention consistently within each module; never mix rates with different denominators.

Table 41. Income and purchasing-power conventions

Module	Exact convention	Avoid
Annual net return	$(1+r_{gross})(1-\text{year-end fee})-1$	Subtracting fees on an unspecified base
Real net return	$(1+r_{net})/(1+\text{matched inflation})-1$	Using unrelated CPI and holding horizons
Quarterly ladder cash	Principal $\times$ annual simple cash rate /4	Calling this an effective compounded return
Accumulation	$B(t)=B(t-1)(1+r_{real})+\text{real contribution}$	Assuming nominal contributions are automatically indexed
Drawdown	$W=B0 / \Sigma(1+r_{real})^{-t}$	Treating finite-horizon depletion as a lifetime guarantee

Each model is deliberately bounded and separately calibrated

A common report does not make the modules one estimated joint macroeconomic forecast.

Table 42. Model modules and key assumptions

Module	Parameters	Main exclusions
Annual real-return grid	Gross 6/10/16%; inflation 4/8/12/18%; fee 1%	Tax, credit losses and return uncertainty
Reinvestment ladder	100,000; 20% old cash rate; 8% new; quarterly resets	Coupon reinvestment, market exit price and fees
Nominal ALM	Assets 100; liabilities 90; 5-year assets /20-year payments	Mortality, indexation, contributions, new business
Indexed ALM	20 years; base indexation 8%; base discount 12%	Actual scheme caps, lags and discretionary indexation
Accumulation / drawdown	Real cash flows; fixed horizons and net real returns	Longevity distribution and probabilistic ruin

A joint dashboard prevents one-sided conclusions

Read income, valuation, liabilities and usable cash together.

Table 43. Exposure channels to examine by balance-sheet type

Holder / promise	Income exposure	Value / liability exposure	Priority record
Short-term saver	Maturity proceeds reprice quickly	Limited term-price exposure if held to redemption	Maturity and net cash received
Fixed-rate bond holder	Coupon initially unchanged	Sale price changes with curve and spreads	Holding horizon; sale / hold treatment
Long fixed benefit pool	Future investment income can fall	Longer liabilities can rise faster than assets	Asset and liability PV01 / cash ladder
Indexed benefit promise	Income must fund escalating payments	Inflation and curve interact	Indexation rule and liability schedule
Insurer with claim / surrender risk	Premium and income timing matter	Forced sale and behavioural optionality	Stressed cash-flow coverage

Source limits remain visible instead of being silently repaired

Primary-table checks, institutional data coverage and model assumptions are separate.

Table 44. Material source and coverage qualifications

Issue	Observation	Treatment
BoG rate snapshots	Five dates retained from preceding report	Renewed source retrieval failed; no numerical refresh
NPRA 2024 BNSSS flows	Prose 8.7/6.5 versus chart 8.80/6.46 bn	Main comparison uses 2025; annex keeps labelled 2024 chart values
Private pension components	Tier chart 80.48 bn versus total 80.49 bn	Retain rounded total; no exact component inference
Reported real return	Deflator and fee / flow conventions unspecified	Do not overwrite with a different CPI measure
Insurance evidence	2024, limited audited submissions; 2025 file unread	Clearly dated and approximate
Legal investment limits	Publication page read; operative PDF not retrieved	No numerical caps or permitted hedges asserted

Sources: BoG (2026; retained inputs); NPRA (2025 report); FSC Ghana (2024 review); NPRA investment guidance; IDER calculations. [S01](#), [S02](#), [S03](#), [S08](#).

Inputs, formulas and report displays can be checked separately

The companion package includes code, exact scenario definitions and a traceable source register.

Table 45. Verification controls and their scope

Layer	Evidence supplied	What it does not establish
Input lineage	Eight source CSVs; exact locators and review status	Independent audit of institution submissions
Numerical engine	Present-value, compounding and cash-flow checks	Correctness of unobserved behaviour assumptions
Reproducibility	Code, version record and replay hashes	Real-time forecast validity
Report integrity	Native editable charts, tables, notes and render review	Formal external certification
Application readiness	Empty portfolio and liability templates	Access to confidential institutional records

Abbreviations and reporting conventions

The same terms apply in the report, numerical files and author’s notes.

Table 46. Terms and units

Term	Meaning	Convention
ALM / PV	Asset–liability management / present value	Values and cash-flow coverage are separate
DB / DC	Defined benefit / defined contribution	Benefit promise and account outcome differ
AUM / BNSSS	Assets under management / Basic National Social Security Scheme	AUM growth is not a return
pp / bp	Percentage points / basis points	1 pp=100 bp
PV01 / duration	Currency sensitivity per bp / relative yield sensitivity	Same curve and valuation date required
Real / nominal	Purchasing-power-adjusted / money-valued	Use matched inflation factor
CSM / IFRS 17	Contractual service margin / insurance-contract reporting standard	Not computed by the model

References and source links 1 / 4

Clickable titles; exact document versions, source locators and verification qualifications are in the companion register.

S01 Bank of Ghana 2026 <u>Monetary Policy Report, July 2026</u> Table A.2, printed p. 41 / PDF p. 43
S02 National Pensions Regulatory Authority 2025 reporting year; accessed 2026 <u>2025 Annual Report</u> Table 1: PDF p. 49; Figure 6: p. 44; Figure 11: p. 46; Figures 12 and 14: pp. 47–48; source-defined 2021–2025 records.
S03 Financial Stability Council, Ghana 2024 review; published 2025 <u>Financial Stability Review 2024</u> Insurance chapter, printed pp. 21–24 / PDF pp. 37–40

References and source links 2 / 4

Clickable titles; exact document versions, source locators and verification qualifications are in the companion register.

S04 International Association of Insurance Supervisors December 2024 framework <u>Insurance Core Principles and ComFrame</u> ICPs 14.2; 16.5–16.8; 20.9
S05 IFRS Foundation Accessed September 2026 <u>IFRS 17 Insurance Contracts: overview</u> About: measurement, service result and insurance finance income/expense
S06 Social Security and National Insurance Trust Accessed September 2026 <u>What We Do</u> Scheme description; Financing of the Scheme

References and source links 3 / 4

Clickable titles; exact document versions, source locators and verification qualifications are in the companion register.

S07 Social Security and National Insurance Trust Accessed September 2026 <u>Superannuation (Old Age) Pension</u> Benefit formula factors; payments to eligible pensioners until death
S08 National Pensions Regulatory Authority Publication page accessed September 2026 <u>Guidelines on Investment of Tiers 2 and 3 Pension Scheme Funds</u> Official publication page and linked investment guidelines
S09 Greenwood, Robin, and Annette Vissing-Jorgensen 14 June 2018 author version <u>The Impact of Pensions and Insurance on Global Yield Curves</u> Denmark 2011 event design; Table 5, PDF p. 39, all five columns. Daily 2008–2013 sample.

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Clickable titles; exact document versions, source locators and verification qualifications are in the companion register.

S10 Jarociński, Marek, and Peter Karadi | 2020

Deconstructing Monetary Policy Surprises—The Role of Information Shocks

American Economic Journal: Macroeconomics 12(2): 1–43. DOI 10.1257/mac.20180090.

S11 CFA Institute | 2020 standards

Global Investment Performance Standards (GIPS) for Firms

Section 2.A: total return, external cash flows, time-weighted and money-weighted measurement.

S12 Di Maggio, M.; A. Kermani; B. J. Keys; T. Piskorski; R. Ramcharan; A. Seru; V. Yao | 2017

Interest Rate Pass-Through: Mortgage Rates, Household Consumption, and Voluntary Deleveraging

American Economic Review 107(11): 3550–3588. DOI 10.1257/aer.20141313.

Judge changing rates against the promise—not the headline yield

The relevant outcome is net income and purchasing power supported by assets, liabilities and liquidity.

What is observed

Benchmark rates and portfolio shares changed. AUM and asset weights describe holdings, not guaranteed retirement income or liability adequacy.

What the models show

Income, real return, asset value and funding can move in different directions. Reset timing and the liability schedule determine exposure.

What makes it actionable

Apply the transparent engine to actual securities, benefits, member flows and cash needs; retain uncertainty and independent review.



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