

Longevity Insurance

for the Irish ARF and vested PRSA market

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Paper classification

Adverse-finding paper: Solvency II standard-formula capital viability.

This is a regulatory-capital viability assessment of a proposed longevity-insurance product for the Irish ARF and vested-PRSA market. The paper prices the product design, reserves it under Solvency II Article 138 and the Article 142 max-of-three lapse construction, and stresses it against the Cairns-Blake-Dowd 99.5% cross-check. **The finding is adverse:** at commercially plausible entry ages (60 to 65), the standard-formula longevity SCR is inadequate against the CBD 99.5% benchmark across every vesting age tested, and Solvency II coverage collapses within the deferral period even at MWR-constrained pricing. The Day-1 own-funds requirement to sustain viable coverage exceeds the writing capacity of the Irish life-assurance sector at plausible market volumes. The paper documents this finding in full arithmetic detail and identifies the DR 2026/269 solvency reform (§12) as the principal forward-looking sensitivity that could change the conclusion.

Keywords: adverse finding · negative-viability assessment · Solvency II standard formula · Article 138 longevity SCR · Article 142 lapse SCR · Cairns-Blake-Dowd 99.5% cross-check · longevity insurance · Irish ARF · vested PRSA · DR 2015/35 · DR 2026/269 · UFR 3.30% · EIOPA risk-free curve · Own Funds trajectory · money's worth ratio (MWR) · heaped-and-trail commission.

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About this edition

This edition consolidates the MWP-2026-04 working paper with its supporting annexes into a single document. The paper presents the central argument and analysis; the annexes provide the technical evidence and audit trail.

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This paper is intended for industry, regulatory, and academic discussion. It is not legal, tax, or financial advice. The analysis is conducted in good faith and from a pro-industry stance: the objective is to support the long-run sustainability of the Irish retirement-income market and to inform the design of a longevity-insurance product suited to Irish ARF and vested PRSA holders.

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Longevity Insurance

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Purpose of the paper

This paper describes the structural inverse of term assurance: a regular-premium deferred whole-of-life annuity, held inside an Approved Retirement Fund (ARF) or vested Personal Retirement Savings Account (PRSA), designed to convert ARF savings into a scheme-internal lifetime income from a chosen vesting age. The paper specifies the product, prices it across the full 16 × 16 entry-age / vesting-age surface under four commission models, reserves it under Solvency II using both the Article 138 longevity stress and a Cairns-Blake-Dowd 99.5 % stochastic cross-check, and identifies the legal and regulatory framework within which such a product would be authorised and distributed in Ireland. The intended audience is actuaries, regulators, brokers, financial advisers, and informed consumers of Irish retirement-income products.

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Executive summary

2.1 The problem

The Irish ARF and vested-PRSA holder carries longevity risk directly, without domestically available insurance against the deep-tail case of surviving well past life expectancy. Immediate annuities do not address this specific need — they insure against the whole of life from purchase, at rates that are commercially unattractive relative to ARF drawdown for many purchasers. The unmet need is specifically at the tail: a scheme-internal, defined-benefit income from a chosen vesting age, funded from the pension vehicle during the accumulation years.

2.2 The design examined

A regular-premium deferred whole-of-life annuity, written inside the ARF or vested-PRSA wrapper, priced on a mutualised basis. Entry age 60 to 75, vesting age 75 to 90, minimum two-year deferral. Premiums paid from the pension vehicle to the insurer during accumulation. Income paid from the insurer to the pension vehicle from vesting age until death. Death or lapse before vesting extinguishes the policy without benefit — no return of premium, no surrender value, no death cover. Forfeited reserves recycle to the surviving pool, which is the pricing lever that makes the design distinctive.

2.3 The analysis

The paper prices the product across the full 16 × 16 entry-age / vesting-age surface, on 31 May 2026 current-rules Solvency II. Central case (entry 65, vesting 80, €400,000 fund, 4% payout) prices at €11,196 per annum on the mutualised basis. The four-route lapse decomposition — affordability, rational-late-lapse, regret, death — is calibrated to Society of Actuaries in Ireland 2013 protection persistency data, with sensitivity envelopes running to the industry upper bound. The mutualisation credit at the central case is 13.8% relative to a non-mutualised equivalent, of which pre-vesting mortality contributes materially more than lapse.

Reserving is analysed under Article 138 (verbatim 20% permanent longevity decrement) with a Cairns-Blake-Dowd 99.5% stochastic cross-check, and — extending the reserving question to its natural boundary — a full Solvency Capital Requirement coverage analysis across the product run-off at five valuation dates (at issue, +5 years, +10 years, at trigger, +5 years post-trigger). The SCR-coverage analysis applies the Article 142 lapse-risk sub-module in its full max-of-three specification (lapse-up, lapse-down, mass-lapse), together with Article 141 expense stress and Article 189 default risk on any reinsurance component, aggregated via the SII standard-formula correlation matrix.

2.4 The finding

On the priced product without additional capital support, SCR coverage stands at approximately 129% at issue but falls to 43% by +5 years, and to progressively deeper negative territory thereafter. The cause is a structural collapse of Own Funds — not growth in the SCR itself. Premium income ceases at vesting while the longevity liability continues to run off for another two or three decades. The Day-1 loading buffer is consumed during the deferral period funding acquisition and maintenance costs, and there is no premium income after vesting to replenish it.

Longevity reinsurance was tested and shown to be insufficient on its own to restore SCR viability. Even a full-cession post-vesting longevity swap at industry-standard pricing (8% to 12% of ceded reserves) leaves the coverage ratio deeply negative from +10 years onward, because the reinsurance addresses the SCR denominator (which is not the primary problem) rather than the Own Funds numerator (which is).

A joint frontier of (premium loading uplift, writing-office Day-1 own funds) was constructed to identify the combinations that achieve SCR coverage of at least 100% at every valuation date. At the point on this frontier where consumer fairness is preserved — Money's Worth Ratio at 0.90, premium ratio to fund below 50%, unsecured-drawdown income exceeded at age 95 across the Prisma multi-asset return sensitivity band — the required Day-1 own funds are approximately **€168,000 per policy** (a **€168 million capital footprint on a 1,000-policy book**), with premium loading uplifted by 9.4% relative to the standalone price. The Money's Worth

Ratio binds at exactly the fairness floor, meaning any further reduction of the capital component through higher premium loading is not available: consumer fairness prohibits it.

2.5 The implication

The design examined does not achieve Solvency II viability at a commercially acceptable capital footprint within the fair-consumer-value envelope. The two constraints are, on this specific design, mutually incompatible. A capital footprint of approximately €168 million per 1,000 policies is prohibitive for all but the two or three largest Irish life offices, and prohibitive at that scale for a product line that would compete for balance-sheet capacity with the writing office's existing profitable business lines. The product cannot be brought to the Irish market on the design specified, in the current-rules Solvency II environment, at a price that a reasonable consumer would accept as fair value.

2.6 What comes next

The forward-look in §12 identifies the design directions under which a longevity insurance product for the Irish ARF market might, in a future paper, become viable:

- Fund-linked payouts that share investment risk with the policyholder and reduce the run-off liability the writing office holds against its own capital
- Cash-out or commutation options at vesting that reduce the post-vesting tail exposure
- Reinsurance-integrated pricing structures under which the reinsurer participates in the accumulation-phase economics rather than only the tail
- The Solvency II 2020 Review — codified in Delegated Regulation 2026/269 and effective 30 January 2027 — which reduces the cost-of-capital rate from 6.0% to 4.75% and refines the volatility-adjustment mechanic
- A domestic or European longevity-reinsurance market of scale, absent at present
- Cross-market or cross-jurisdictional pooling structures that reduce isolated longevity concentration

None of these directions is examined in this paper. Each is a substantive piece of subsequent work. The purpose of this paper is to establish the finding for the specific design examined, and to place the design directions on record for whoever takes the next step.

§1. The problem this paper investigates

The Irish retirement-income market has, over three decades of policy change, transferred longevity risk from institutional balance sheets onto individual pension savers. The Finance Act 1999 introduced the Approved Retirement Fund (ARF) as an alternative to compulsory annuitisation ([TCA 1997 Part 30, sections 784A–784B, as amended](#)). Successive Finance Acts through to the [Finance Act 2024](#) and the [Finance Act 2025](#) have widened the accessible retirement-vehicle set and lifted the Standard Fund Threshold to €2.2m for 2026, rising to €2.8m by 2029.

The population served by these vehicles is exposed to a mortality distribution that is neither symmetric nor short-tailed. On the Irish Life Tables No.17 period basis ([CSO ILT17, 2015–2017, published 2020](#)), a male aged 65 has period life expectancy of 18.3 years and a female 21.0 years. On a cohort basis with CMI_2022 improvements ([CMI Ltd., Working Paper 177, June 2023](#)) the same person has a materially longer expected lifespan and, more importantly, a substantial probability of surviving into their late nineties. The Society of Actuaries in Ireland records survival to age 90 for a healthy Irish 65-year-old male at approximately one in three, and survival to age 95 at approximately one in ten ([SAI Longevity Committee — Continuous Mortality Investigation Ireland 2015–2017](#)).

The ARF drawdown arithmetic does not survive that distribution comfortably. An ARF drawing 4% of the opening balance annually — a common heuristic — depletes with probability materially above zero on any set of return assumptions consistent with current EUR risk-free rates. On the [EIOPA risk-free rate term structure for 31 May 2026, EUR, no volatility adjustment](#) (ultimate forward rate 3.30%, last liquid point 20 years, convergence 40 years), the accumulated fund cannot systematically outrun a 4% drawdown over a 30-year horizon.

The Irish ARF and vested-PRSA holder therefore carries longevity risk directly. There is no domestically available market product that pays a scheme-internal income to protect against the deep-tail case of surviving into the late eighties, nineties or beyond. Immediate annuities from Irish life offices address a different need — the certainty of some income from purchase — and at current EUR interest rates their gross rates are commercially unattractive relative to ARF drawdown for many purchasers. The unmet need is specifically at the tail.

1.1 The design this paper examines

A natural response to this unmet need is the structural inverse of term assurance: a regular-premium **deferred whole-of-life annuity** written inside the ARF or vested-PRSA wrapper, priced on a mutualised basis under which pre-vesting mortality and lapse forfeit accumulated reserves to the surviving pool. Premiums are paid from the pension vehicle during the accumulation years; income is paid back into the pension vehicle from a chosen vesting age until death. Death or lapse before vesting extinguishes the policy without benefit. This design is described in full in §2.

The paper's original purpose was to specify, price, and reserve this product across the full range of feasible entry and vesting ages, and to identify the legal and regulatory framework within which it would be authorised and distributed in Ireland.

1.2 What this paper finds

The paper's investigation concludes that the product as specified does not achieve Solvency II viability at any pricing point consistent with fair consumer value. The binding constraint is not longevity risk itself, nor the mutualisation mechanic, nor the lapse assumption. The binding constraint is the **structural shape of the cashflow**: a regular-premium deferred annuity collects premium during the accumulation years and pays out for potentially two or three decades thereafter. Under current-rules Solvency II — 31 May 2026 EIOPA risk-free rate, Article 138 longevity stress with the verbatim 20% permanent decrement, cost-of-capital 6.0% per Article 39 of Delegated Regulation 2015/35 — the writing office's own funds trajectory turns sharply negative from approximately five years into the deferral period. The Solvency Capital Requirement itself is modest and grows only modestly; the coverage ratio collapses because the numerator collapses, not because the denominator explodes.

At the point on the viability frontier where consumer fairness is preserved (Money's Worth Ratio at the 0.90 floor conventionally used as the boundary between fair value and materially expensive value, premium \leq 50% of ARF fund on a running basis, unsecured-drawdown comparator income exceeded at age 95), the writing office requires **Day-1 own funds of approximately €168,000 per policy**, corresponding to a capital footprint of approximately **€168 million on a 1,000-policy book**. Premium loading cannot carry more than approximately one quarter of this requirement without breaching consumer fairness. The remainder must come from writing-office regulatory capital.

This capital footprint is not a criticism of the product design. It is a description of the underlying longevity risk when it is isolated from a diversifying life-office balance sheet and modelled against a run-off. Longevity insurance globally is a capital-intensive institutional business — every jurisdiction that has serious longevity products relies on either large diversified life-office capital, external longevity reinsurance, or both. Ireland has no domestic longevity reinsurance market of scale, and the capital requirement identified here is prohibitive for all but the two or three largest Irish life offices, and prohibitive at that scale for a product line that would compete for balance-sheet capacity with the writing office's existing business.

The paper concludes that this specific product design, at the current-rules Solvency II calibration and in the current Irish market structure, does not stand up to scrutiny as a commercial proposition. It sets out the analysis in full so that the finding can be verified, and so that the design directions which might reduce the capital requirement in a future paper can be identified precisely.

1.3 What the paper contributes

The paper contributes:

- A specification of the mutualised deferred longevity design suited to Irish ARF and vested-PRSA holders (§2)

- A pricing basis calibrated to current-rules Solvency II with the 31 May 2026 EIOPA EUR no-VA risk-free rate curve (§3)
- A four-route lapse decomposition anchored to Irish empirical evidence from the Society of Actuaries in Ireland's 2013 protection persistency study, cross-checked against qualitative structural evidence from US qualifying longevity annuity contracts and Central Bank of Ireland consumer research (§6.5)
- A reserving analysis under Solvency II combining the Article 138 longevity stress with a Cairns-Blake-Dowd 99.5% stochastic cross-check, and — new to this paper — a full Solvency Capital Requirement coverage assessment across the product run-off (§6.6)
- A consumer-fairness overlay comparing the priced product to unsecured ARF drawdown across a range of investment-return scenarios calibrated to the Zurich Prisma multi-asset fund range (§7)
- An identification of the viability frontier of (premium loading, writing-office capital) pairs achieving SII coverage at every valuation date, and the finding that no point on this frontier is commercially viable within the fair-consumer-value envelope (§7)
- A conclusion setting out why the design fails, and the design directions and market developments under which a longevity insurance product of this class might become viable in the future (§12)

The intended audience is actuaries, regulators, insurance-industry practitioners, and informed consumers of Irish retirement-income products.

§2. The product

2.1 Statement in plain language

The product is a **regular-premium deferred whole-of-life annuity**. It is written by an authorised Irish (or EEA-passporting) life office. It is held inside the policyholder's ARF or vested PRSA. Both cashflows — premium out and income in — pass between the pension vehicle and the insurer; the natural person never touches either flow directly.

The policyholder selects an entry age y (60 to 75 inclusive) and a vesting age x (75 to 90 inclusive), subject to a minimum two-year deferral ($x - y \geq 2$). Between y and x , the ARF or vested PRSA pays a monthly premium P to the insurer. From x until the policyholder's death, the insurer pays a monthly income B into the ARF or vested PRSA. If the policyholder dies before reaching x , the policy expires valueless; there is no death benefit, no return of premium, no surrender value.

The two-year minimum deferral is a deliberate product-design constraint: it excludes near-immediate annuity configurations ($x - y < 2$) at which the product's tail-cover value is negligible and the mortality leverage in premium is insufficient to compete with an ordinary immediate annuity. Feasibility remains challenged at low deferrals just above the minimum — the surface is priced across every feasible cell but the near-minimum corner is not a commercially plausible sale point.

2.2 The organising idea

This product is the structural inverse of term assurance. Term assurance pays on death before a boundary. This product pays on survival past a boundary. Term assurance is the largest single non-mortgage-related protection line in the Irish market and is understood by every adviser and every consumer who has ever considered mortgage protection. The proposition here is symmetric and just as tractable.

Attribute	Term assurance	This product
Contingent event	Death before boundary	Survival past boundary
Cashflow if event occurs	Insurer pays lump sum	Insurer pays monthly income until death
Cashflow if event does not occur	Premiums paid, no benefit	Premiums paid, no benefit
Underwriting basis	Individual medical	Population + annuitant selection

Attribute	Term assurance	This product
Primary risk borne by insurer	Mortality (early death)	Longevity (late death)

The absence of any benefit on the counterfactual event is the same in both directions. Term assurance is not disparaged for the fact that the modal outcome for a healthy 30-year-old is “premiums paid, no benefit received.” Neither should this product be. The disclosure and suitability framework must nonetheless be honest about this – §10 addresses that.

2.3 What the product is not

- It is not an immediate annuity. Cashflow does not start at purchase; it starts at x .
- It is not a guaranteed minimum withdrawal benefit. There is no ARF fund attached to the contract; the ARF and the policy are separate assets held by the same beneficial owner.
- It is not a with-profits or unit-linked policy. There is no market exposure at any point.
- It is not a return-of-premium product. Premium paid in accumulation is not returned on early death or otherwise.

2.4 Wrapper

Both legs are scheme-internal. The premium leaves the ARF (or vested PRSA); the income returns to the ARF (or vested PRSA). Payment to the natural person happens only through the ordinary ARF drawdown mechanics, subject to the imputed distribution rules under [section 790D TCA 1997](#) and the imputed-distribution rate schedule in [Revenue Pensions Manual Chapter 28](#).

Two vehicles are in scope: the ARF and the vested PRSA. Vested PEPP parity is out of scope pending maturation of the Irish PEPP market. The occupational-scheme pre-vesting route is technically feasible but operationally unusual; it is discussed in §10.

§3. Pricing basis

3.1 Equivalence pricing identity

The classical equivalence pricing identity, monthly annuities-due, gross of loadings:

$$P \cdot \ddot{a}_{[y]: \overline{x-y}|}^{(12)} = B \cdot x-y|\ddot{a}_{[y]}^{(12)}$$

The left-hand side is a temporary monthly annuity-due over the accumulation phase, contingent on survival to each payment date. The right-hand side is a deferred whole-of-life monthly annuity-due commencing at x , again contingent on survival at each payment date. There is no reversionary element on either side. This is the cheapest form of deferred annuity in the classical taxonomy: every euro of mortality leverage flows to the policyholders who reach the vesting age.

3.2 Mortality basis (Option A, locked)

The mortality stack in this paper is Option A, locked in the [Phase A research dossier](#) and unchanged since 19 June 2026:

Layer	Specification	Primary source
Population base	ILT17 period, terminal age 105, extended to 120 via Kannisto logistic fitted to ages 90–100	CSO ILT17

Layer	Specification	Primary source
Insured-lives adjustment	IILMI annuitant A/E factors (SAI, 2009–2015 investigation, published March 2019), unmodified against ILT17	SAI Longevity Committee – IILMI investigation
Selection haircut	× 0.90 applied throughout the base, reflecting longevity-optimist self-selection into a product that expires valueless on early death	Author, documented in Annex A
Improvement projection	CMI_2022 / CMI Working Paper 177 with SAI 2020 Irish-calibrated initial improvements where available; CMI cubic convergence to long-term rate 1.5%	CMI Ltd. WP177, June 2023
Stochastic stress	CBD 99.5% qx multipliers at ages 65 / 75 / 85 = 0.71275 / 0.76806 / 0.82834	Cairns–Blake–Dowd two-factor model, England & Wales calibration bisected against Annex A Table A.6 LE ratios; see Annex A §A.4b.4
Build seed	<code>numpy.random.default_rng(20260620)</code>	Author

The two selection layers do different work. The IILMI A/E factor captures market-level annuitant selection observed across all Irish insured annuity portfolios. The × 0.90 haircut captures product-specific self-selection into a design that pays nothing on early death and is therefore attractive only to policyholders with above-average survival expectations. Full derivation, fan charts, and jurisdictional bridging (CMI is calibrated on England and Wales data; the SAI 2020 initial-improvement recalibration bridges to the Irish population) are given in Annex A.

3.3 Discounting

The EIOPA risk-free interest-rate term structure of 31 May 2026, EUR, no volatility adjustment, published 3 June 2026. Parameters: ultimate forward rate 3.30%; last liquid point 20 years; convergence period 40 years; Smith–Wilson α 0.059979; credit risk adjustment 10 bps. No volatility adjustment is applied – the reserving stack downstream is Standard Formula and does not qualify for VA under Article 77d of Directive 2009/138/EC.

3.4 Loadings

Loadings anchored to primary sources from the Irish life-office SFCR repository, year-end 2024, supplemented by SAI Financial and Economic Assumptions March 2024 and the Milliman Ireland SFCR analysis May 2025:

Loading	Point estimate	Basis
Provider margin	3.0% of PVP	Royal London Insurance DAC SFCR 2024 – operating profit before tax €11.7m / PVNBP €353m = 3.3%. Rounded conservatively to 3.0%. The sole computable ratio from Irish primary sources.
Per-policy maintenance expense	€80/year (2025 base)	No Irish SFCR discloses per-policy euro amounts; €80/year is a placeholder based on market convention (€50–€120 range for medium-complexity protection). Sensitivity at €100/year priced in the workbook.
Expense inflation	2.5% p.a.	ECB long-term inflation target 2.0%, plus Irish earnings differential ~0.5% per SAI 2024 paper. Consistent with Zurich Life Assurance plc SFCR 2024 §D.2

Loading	Point estimate	Basis
		(0.25% increase → -1% solvency coverage).

The full term-assurance pricing comparator, with the six SFCRs individually assessed and gaps documented, forms part of the audit trail available on request.

3.5 Commission

The product is priced in parallel under **four commission models**:

#	Model	Structure	Role in paper
1	Heaped+Trail	100% of Year 1 premium + 5% of every subsequent premium in accumulation	DEFAULT — headline figures throughout
2	Zero commission	Zero across all years	Pricing floor benchmark; execution-only, direct-to-consumer, fee-based advisory, trustee-directed
3	Level 20%	20% of every premium, flat, throughout accumulation	Comparator
4	Industry reference	100% Y1 + 20% Y2-4 + 3% Y5+	Comparator, flagged as “stretched” at long accumulation terms

Model 2 (Zero) was added to the product specification on 01 July 2026 as a pricing floor. It is not the recommended distribution model; it is the reference against which the impact of each other model can be seen. The Heaped+Trail model is the recommended default because it matches the risk carried by the adviser (who advises the product once, at inception, and then services the policy over decades) with the compensation structure (front-loaded, then a small ongoing trail for servicing).

Product design allows commission to be dialled to zero. Any policy sold on a zero-commission basis is priced using Model 2’s premium schedule; the resulting premium is the floor consistent with the equivalence pricing identity plus the 3.0% margin and expense loadings.

§4. Six worked examples

Six examples are presented under all four commission models. All figures are gross monthly premiums (P) required to secure the specified monthly income (B), on the Option A mortality basis and the EIOPA 31 May 2026 discount curve. Loadings and commission as §3.4/§3.5. Full workbook rows in the pricing workbook, sheet V07_Examples.

Example 1 — Early-retiree, modest top-up

Entry age 60, vesting age 80, income target €500/month, 20-year accumulation.

Commission model	Monthly premium P	Loading over equivalence	Annual premium
Heaped+Trail (default)	€192.77	+26.7%	€2,313.21
Zero commission	€169.89	+11.7%	€2,038.67
Level 20%	€214.02	+40.7%	€2,568.19
Industry reference	€196.06	+28.9%	€2,352.74

Equivalence-only premium (no loadings, no commission): €152.16/month.

Example 2 – Reference case

Entry age 65, vesting age 85, income target €1,000/month, 20-year accumulation.

This is the paper's central illustration.

Commission model	Monthly premium P	Loading over equivalence	Annual premium
Heaped+Trail (default)	€248.01	+23.9%	€2,976.08
Zero commission	€217.87	+8.8%	€2,614.42
Level 20%	€274.46	+37.1%	€3,293.51
Industry reference	€252.64	+26.2%	€3,031.65

Equivalence-only premium: €200.26/month. Total expected premiums paid if alive to vesting: €59,521.60 (Heaped+Trail).

Example 3 – Late-retiree, late-vest

Entry age 70, vesting age 85, income target €1,000/month, 15-year accumulation.

Short deferral, sharp mortality leverage: fewer years of survivorship discount reduce the mortality benefit compared with the reference case.

Commission model	Monthly premium P	Loading over equivalence	Annual premium
Heaped+Trail (default)	€357.96	+24.5%	€4,295.56
Zero commission	€308.08	+7.2%	€3,696.98
Level 20%	€388.10	+35.0%	€4,657.20
Industry reference	€368.70	+28.2%	€4,424.40

Equivalence-only premium: €287.51/month.

Example 4 – Late-retiree, early-vest

Entry age 70, vesting age 75, income target €500/month, 5-year accumulation.

Five-year deferral; the shortest accumulation window on the surface. This is the corner where the equivalence pricing identity converges toward the immediate annuity case, and where Industry Reference loading is at its most severe.

Commission model	Monthly premium P	Loading over equivalence	Annual premium
Heaped+Trail (default)	€1,496.82	+43.4%	€17,961.86
Zero commission	€1,104.43	+5.8%	€13,253.15
Level 20%	€1,391.29	+33.3%	€16,695.44
Industry reference	€1,702.07	+63.0%	€20,424.82

Equivalence-only premium: €1,044.11/month. **Note the 63% Industry-Reference loading:** the 100% Y1 + 20% Y2–4 structure absorbs a disproportionate share of a 5-year premium base and is not commercially plausible at this term. This example is included precisely to document that constraint.

Example 5 – Maximum longevity insurance

Entry age 60, vesting age 85, income target €2,000/month, 25-year accumulation.

The longest accumulation window at a substantial income target. Lowest probability of claim, sharpest term-
assurance parallel: for many policyholders this is “premiums paid, no benefit received.”

Commission model	Monthly premium P	Loading over equivalence	Annual premium
Heaped+Trail (default)	€361.25	+20.2%	€4,335.00
Zero commission	€321.24	+6.9%	€3,854.88
Level 20%	€404.68	+34.7%	€4,856.19
Industry reference	€365.61	+21.7%	€4,387.33

Equivalence-only premium: €300.46/month.

Example 6 – Deep-tail longevity insurance

Entry age 60, vesting age 90, income target €1,000/month, 30-year accumulation.

Approximately a one-in-three probability of ever claiming, on the Option A basis. The corner of the surface most analogous to catastrophe term assurance: low premium, contingent-remote payout.

Commission model	Monthly premium P	Loading over equivalence	Annual premium
Heaped+Trail (default)	€86.06	+33.8%	€1,032.78
Zero commission	€76.91	+19.6%	€922.96
Level 20%	€96.89	+50.7%	€1,162.69
Industry reference	€86.87	+35.1%	€1,042.44

Equivalence-only premium: €64.30/month.

4.1 Reading the six

Loading percentages under the Heaped+Trail default range from 20.2% (Example 5, long term at high income) to 43.4% (Example 4, short-term high-premium case). The equivalence-only premium is unaffected by commission model – it is the pure biometric floor. The Zero-commission case is 5.8%–19.6% above equivalence: the 3% margin and per-policy fixed expense loading account for that gap, and the expense fraction is larger at low absolute premium levels (Example 6).

The examples illustrate that the product is workable across the parameter surface but that commission structure has a first-order effect on premium level. The zero-commission floor should be regarded as the fair-value comparator when the paper’s argument turns to consumer disclosure and value assessment.

Rounding note (Examples 1–6 and Annex B.3). The monthly premium and annual premium columns in Examples 1–6 and in the Annex B.3 full-surface table are each an independent 2-decimal rounding of the unrounded engine output. Multiplying the displayed monthly premium by 12 will not always reproduce the displayed annual premium to the cent, because the annual figure is computed from the full-precision monthly value before rounding, not from the displayed monthly. The residual is at most €0.06 per row and is an artefact of display precision, not a data or arithmetic error. The auditable source at unrounded precision is `panel_v07_7x4.csv` and the workbook sheet `V07_Examples`.

§5. Headline panel

7-row × 4-column canonical slice of the pricing surface, Heaped+Trail default, income target €1,000/month.

Entry ages (rows): 60, 63, 65, 68, 70, 72, 75. Vesting ages (columns): 75, 80, 85, 90. Full-surface heatmap and downloadable CSV in Annex B (sheets V07_Panel_7x4 and V07_Surface_HeapedTrail).

Entry age	Vest 75 (€/mo)	Vest 80 (€/mo)	Vest 85 (€/mo)	Vest 90 (€/mo)
60	713.86	370.76	187.08	86.06
63	948.39	455.87	219.86	97.25
65	1,196.73	534.43	248.01	106.55
68	1,893.46	711.51	304.78	124.48
70	2,955.67	900.44	357.96	140.21
72	6,195.21	1,203.76	431.73	160.41
75	—	2,253.80	612.17	204.31

Bold cell: reference case (entry 65 / vest 85, Example 2 headline panel).

Convention note. The headline panel above is presented in the income-target convention (monthly premium P for a €1,000-per-month indexed income). The negative-result narrative in §6.6, §7, §8, §9 and §12 anchors on the Example 2 reference case (entry 65 / vest 80, €400,000 fund, 4% payout = €16,000 per year CPI-indexed from inception). Both conventions price to the same underlying equivalence identity of §3.1; the choice between them is presentational. The reference-cell cross-reference between the two conventions is set out at §6.6.1 (Example 2 pricing table) and in the workbook sheet V07_Examples; a full 7×4 grid is presented only in the income-target convention because the fund-and-payout convention requires cell-specific fund and payout inputs that are not uniformly defined across the panel.

The panel is monotonically decreasing with vesting age (a longer deferral gives more mortality leverage and lower premium at fixed B) and monotonically increasing with entry age within any given vesting column (a shorter deferral gives less leverage). The 72/75 corner (€6,195/month for a €1,000/month income after a 3-year deferral) is close to an immediate annuity at that age and illustrates the surface boundary; it is not a commercially plausible sale point. The panel is complete for reference; §10 imposes the commercial restraint.

Commission-model comparison at the reference cell (entry 65, vest 85, income €1,000):

Model	Monthly premium
Zero	€217.87
Heaped+Trail (default)	€248.01
Industry reference	€252.64
Level 20%	€274.46

§6. Reserving under Solvency II

6.1 Framework

The insurer writing this contract computes technical provisions under [Directive 2009/138/EC, Article 77](#), transposed into Irish law by [S.I. No. 485 of 2015](#), and Articles 38–61 of [Commission Delegated Regulation \(EU\) 2015/35](#). The Line of Business classification is **LoB 32 – Other life insurance**, per Article 55(4) of the Delegated Regulation (residual life category; no unit-linking, no with-profits, not an annuity arising from a non-life claim).

6.2 Best Estimate Liability

BEL is the present value of expected future net cashflows on a probability-weighted basis, discounted at the EIOPA risk-free rate. During the accumulation phase, BEL is the present value of expected future income payments **net of** expected future premiums. It is signed:

- **Negative on the central basis** when expected future premiums exceed the present value of expected future income (the mortality-and-loading buffer sits on the provider side).
- **Positive on a stressed basis** when longevity improvement pushes the value of expected income above the value of expected premiums.

At the reference cell (entry 65, vest 85, Heaped+Trail default, income €1,000/month), the central BEL is -**€6,074**. This is the correct sign under central assumptions.

6.3 SCR longevity: Article 138 versus a CBD 99.5% cross-check

Article 138 of the Delegated Regulation prescribes a permanent 20% reduction in mortality rates as the standard-formula longevity stress. The alternative stress considered here is a Cairns-Blake-Dowd two-factor model calibrated to Irish and adjacent-jurisdiction data, run to a 99.5%ile longevity outcome. The full derivation is in *Annex A*.

Reference cell reserving diagnostics (entry 65, vest 85, Heaped+Trail default):

Metric	Value
BEL central	-€6,074
BEL under Article 138 stress (20% qx down)	€194
BEL under CBD 99.5% qx stress	€2,844
SCR longevity (Article 138)	€6,268
SCR longevity (CBD 99.5%)	€8,918
Ratio Art.138 / CBD 99.5%	0.7028
Article 138 verdict	INADEQUATE

The Article 138 SCR is approximately 70% of the CBD 99.5% SCR at the reference cell. The regulatory minimum sits **materially below** the actuarially implied 99.5%ile calibrated on the current mortality basis.

6.4 Panel-level verdict

The reserving cross-check has been run across the full 7x4 headline panel under the Heaped+Trail default. The results, cell by cell, are in the workbook sheet `V07_Reserving_Panel`. The pattern is:

Entry age	Vest 75	Vest 80	Vest 85	Vest 90
60	inadequate	inadequate	inadequate	inadequate
63	inadequate	inadequate	inadequate	inadequate
65	inadequate	inadequate	inadequate	inadequate
68	marginal	marginal	marginal	inadequate
70	marginal	marginal	marginal	marginal
72	marginal	marginal	marginal	marginal
75	—	marginal	marginal	marginal

Where “inadequate” is Article 138 SCR / CBD 99.5% SCR < 0.75, “marginal” is 0.75–0.95, and “exceeds” is ≥ 0.95. This is the classifier applied in the workbook sheet `V07_Reserving_Panel` column K. **The Article 138 stress never exceeds a CBD 99.5% cross-check anywhere on the panel.** The panel maximum ratio is 0.9006 at entry 75 / vest 80; every cell in the 7x4 grid falls below the 0.95 threshold.

At the commercially plausible entry ages 60 to 65 — the ages at which most ARF and vested-PRSA policyholders would purchase this product — **the Article 138 SCR is inadequate across every vesting age from 75 to 90**. At entry 68 and above the verdict softens to marginal in most cells; it never exceeds. Selection into this product design is precisely the population most exposed to longevity risk, so the entry-age concentration is on the low side of the panel — i.e., in the “inadequate” region.

6.5 Sub-modules and treatment — mortality primary, Article 142 lapse-down live

The Article 138 longevity stress (primary in decumulation) and the mortality stress (Article 137, applies in accumulation) between them capture the direct mortality-side capital exposure of the product. In the paper’s original design intent the lapse sub-module was described as “dormant by design” — the product has no surrender value, no cash bonus, and expires valueless on early death, so there is no policyholder-side lapse-inducing feature. The full SCR treatment developed in §6.6 shows that this intuition is right on the lapse-up direction but wrong on the lapse-down direction:

- **Longevity (Article 138):** primary risk in decumulation. Dominant SCR driver at the reference cell (§6.3, §6.4). The 20% permanent qx decrement is the standard-formula stress; a CBD 99.5% cross-check sits materially above it (§6.3, §6.4). Article 138 is unchanged in DR 2026/269 (§12.3).
- **Mortality (Article 137):** applies in accumulation only. Early death benefits the insurer (premium stream ceases; BEL extinguished). Standard formula captures the bilateral position.
- **Lapse (Article 142): live in the down direction.** The product design that made lapse feel “dormant” — no surrender value, no cash bonus, no policyholder incentive to lapse — is exactly what makes the Article 142 max-of-three stress bind on the *reduction* side of the lapse rate. A permanent 40% reduction in the assumed lapse rate holds more policies in force for longer, exposing more of the writing office’s balance sheet to the tail-longevity risk. The lapse-down limb of the max-of-three binds at $t=0$, $t=5$ and $t=10$ (€9,987, €9,007 and €6,083 per policy respectively) and drives the SCR-coverage trajectory documented in §6.6.6. See §6.6 for the full construction, decomposition, and finding.
- **Expense (Article 141):** applies to per-policy maintenance expense uncertainty; €80/year (2025 base) with 2.5% p.a. inflation as §3.4.
- **Life catastrophe (Article 140):** required pro forma; a mass-mortality catastrophe benefits the in-accumulation insurer, so the net SCR contribution is likely modest.

The upshot is that the standard-formula lapse module, correctly applied under the max-of-three construction, is not silent on this product. It binds in the reduction direction, at durations at which the writing office’s Own Funds have already been consumed by the risk-margin unwind and the accumulation-phase cashflow profile. §6.6 sets out that construction in full and traces its effect on SCR coverage across the twenty-year projection horizon.

§6.6 Reserving and SCR-coverage — the viability finding

6.6.1 Purpose of this section

Section 6.3 established that the Article 138 permanent-20% longevity stress systematically understates a CBD 99.5% internal cross-check across the commercially plausible entry-age panel. That finding — a comparative shortfall of the standard-formula stress — is one input to the reserving picture. This section presents the second, more consequential input: a full Solvency II SCR-coverage projection of the mutualised, forfeiture-to-pool regular-premium design across the deferral and payout phases, and the viability frontier it implies for a writing life undertaking.

The finding is negative. The product design examined in §5 does not clear a 100% SCR-coverage test at every valuation timepoint on any own-funds basis that a single Irish life undertaking could plausibly bring at back-book scale, once a fair-consumer constraint ($MWR \geq 0.90$) is imposed. This section sets out the reserving framework, the SCR sub-module build, the run-off Own Funds trajectory, the Article 142 sub-shock treatment,

the reinsurance overlay, and the viability frontier — in that order — so that the negative conclusion in §7 and §12 rests on evidence a reader can audit end-to-end.

All figures below are the central case unless stated otherwise: entry age 65, trigger/vest age 80, fund €400,000, payout rate 4.0% p.a. of the fund at inception (CPI-indexed), mutualised cohort basis, current-rules Solvency II, valuation date 31 May 2026.

6.6.2 Valuation basis and framework

The valuation basis is held constant across every calculation in this section:

Item	Basis	Source
Regime	Current-rules Solvency II (pre-DR 2026/269)	Directive 2009/138/EC; DR 2015/35; S.I. No. 485 of 2015
Line of business	LoB 32 — Other life insurance	DR 2015/35 Article 55(4)
Valuation date	31 May 2026	Paper reference date
Risk-free rate	EIOPA EUR curve, no volatility adjustment, 31 May 2026	EIOPA monthly RFR publication
Ultimate forward rate	3.30%	EIOPA UFR 2026 methodology
Last liquid point	20 years	EIOPA EUR LLP
Risk-margin CoC	6.0%	DR 2015/35 Article 39
Longevity stress	Article 138 verbatim, 20% permanent decrease in mortality	DR 2015/35 Article 138
Lapse stress	Article 142 max of three sub-shocks (up +50%, down -50%, mass 40%)	DR 2015/35 Article 142
Expense stress	Article 141 joint reading (10% level uplift + 1pp inflation add)	DR 2015/35 Article 141
Correlation matrix	Life-underwriting Annex IV: longevity↔lapse 0.25, lapse↔expense 0.50, longevity↔expense 0.25	DR 2015/35 Annex IV

DR 2026/269 (published 30 January 2027, effective in stages from 2027) reduces the risk-margin cost-of-capital rate to 4.75% and introduces a lambda-scaling floor on the risk margin. It is not applied here. The forward-look in §12 quantifies its sensitivity. The verdict below is on the regime a writing office would face if it sought regulatory approval before the DR 2026/269 measures apply.

6.6.3 Best Estimate Liability — prospective identity

The at-issue BEL identity used through §6.2 generalises directly to a prospective BEL at any future valuation date $t \in \{0, 5, 10, 15, 20\}$ years:

$$BEL(t) = PV_{t}[expected\ future\ payouts] - PV_{t}[expected\ future\ premiums \times (1 - margin - commission)] + PV_{t}[expected\ future\ maintenance\ expenses] - PV_{t}[expected\ future\ forfeitures\ credited\ to\ pool]$$

All four legs share the mortality-and-lapse-decremented in-force projection of the original cohort, discounted at the EIOPA EUR curve, and use the mutualisation-engine cash-flow mechanics locked at Phase 2 (§5). The prospective BEL identity is a strict generalisation, not a re-implementation: the SCR module (`03_scr_module.py`, [Phase 2c build report](#)) invokes the pricing engine's own `compute_risk_margin()` and `prospective_bel()` routines, only rebasing the projection window from $[0, \infty)$ to $[t, \infty)$.

On the central basis, BEL is negative during deferral (mortality-and-loading buffer sits on the provider side and forfeited premiums recycle into the pool subsidy). It turns positive as the cohort approaches trigger, at which point the deferred annuity liability crystallises and no further premium income offsets it.

6.6.4 Risk margin construction

Risk margin under DR 2015/35 Article 37 is the cost of holding non-hedgeable-risk SCR to run-off, discounted at the risk-free rate:

$$RM = CoC \cdot \sum_{t \geq 0} \frac{SCR_{RU}(t)}{(1 + r_{t+1})^{t+1}}$$

with CoC = 6.0% (Article 39) applied to the reference-undertaking SCR projection. The reference-undertaking SCR projection uses Article 138's 20% permanent mortality decrease as the primary longevity leg per DR 2015/35 Article 38(1)(h), which – following the practitioner reading of Article 38 the paper follows through §6.3 – is applied verbatim rather than replaced by an internal cross-check. The internal CBD 99.5% comparator remains a §6.3 diagnostic on the adequacy of the standard-formula stress; it does not substitute for the Article-138-based risk margin used in reserving.

The current-rules RM contribution to BEL + RM at the central cell is small relative to Own Funds movements over the deferral run-off. It is not the driver of the finding below.

6.6.5 SCR sub-modules – construction, calibration, and Article 138 primary role

Aggregate SCR at each valuation timepoint is the standard-formula square-root aggregation of three life-underwriting sub-modules (longevity, lapse, expense) via the DR 2015/35 Annex IV correlation matrix. Life catastrophe (Article 140) applies pro forma and, on this design, benefits an in-accumulation insurer (a mass-mortality event extinguishes premium streams and terminates future annuitisation liability); its net contribution to aggregate SCR is not material and is set to zero for the purposes of this build. Mortality (Article 137) applies in accumulation only and, on this design, similarly benefits the insurer (early death terminates the deferred annuity liability while premiums to date are retained); it enters the aggregation with a floored-at-zero contribution.

Longevity – Article 138 verbatim, applied prospectively. The 20% permanent decrease in mortality rates is applied at each valuation date t to the mortality basis governing prospective cash flows from t onward. The pre- t in-force path is fixed at the central-basis projection, per standard SCR-at-a-valuation-date methodology (the stress acts on the BEL as it stands at t , not on its history). $SCR_{longevity}(t)$ is ΔBEL between the stressed and central prospective projections. It grows from €14,310 at issue to a peak of €18,004 at trigger before easing to €17,018 at $t=20$ as the survivor pool runs off.

Lapse – Article 142 max of three sub-shocks. Article 142(1) DR 2015/35 defines SCR_{lapse} as the maximum of a permanent +50% lapse-rate increase, a permanent -50% lapse-rate decrease, and a one-off 40% mass-lapse event, with the Article 142(6)(b) gating condition ($\max(0, \Delta BEL)$) applied to each leg independently. The three sub-shocks are computed separately and aggregated by the max operator. The lapse-up and lapse-down calibrations are uncapped (the $\pm 50\%$ relative shift is unconditional under DR 2015/35 – the SAI 2013 11.7% ceiling belongs to the engine's "adverse" bespoke sensitivity multiplier only, not to the regulatory shock). Lapse-down is floored at zero per duration bucket but does not numerically bind on the central curve. Full derivation and lapse-mechanics build: [Phase 2e report §2](#).

Expense – Article 141 joint reading. The stress applies the 10% expense-level uplift and the 1pp permanent addition to expense inflation (2.5% \rightarrow 3.5%) simultaneously, per the joint reading of Article 141(1)(a)–(b). This is the more common and more conservative reading. The joint stress contributes €228–€383 across timepoints – an order of magnitude below $SCR_{longevity}$ and immaterial to the aggregation.

Correlation aggregation.

$$SCR_{agg}(t) = \sqrt{\sum_{i,j} \rho_{ij} SCR_i(t) SCR_j(t)}$$

with $\rho_{\text{longevity,lapse}} = 0.25$, $\rho_{\text{lapse,expense}} = 0.50$, $\rho_{\text{longevity,expense}} = 0.25$ (Annex IV life-underwriting matrix). Because SCR_expense is small and SCR_lapse is either the binding sub-shock at $t=0$ or zero at $t \geq 15$ (see below), the aggregation adds only a modest amount to SCR_longevity in the middle of the projection.

Article 138 primacy on this design. Section 6.3 established that Article 138 understates a CBD 99.5% internal cross-check by 28.7–30.7 percentage points at entry ages 60–65. That comparative shortfall is a live finding of this paper (§7 F3), but the SCR-coverage projection below uses Article 138 verbatim as the primary longevity leg, because a writing office seeking regulatory approval on the standard formula must clear that test — an internal-model or ORSA-add-on view is downstream of the standard-formula gate. Substituting CBD 99.5% for Article 138 in the aggregation would worsen the negative result below, not improve it; the Article-138 primary presentation is therefore conservative for the writing office.

6.6.6 Article 142 sub-shock decomposition — where the lapse SCR actually sits

The three Article 142 sub-shocks behave very differently on this zero-surrender-value, forfeiture-to-pool design. The full max-of-three decomposition (from [Phase 2e §2](#)) is:

t (yrs)	Timepoint	SCR lapse-up (€)	SCR lapse-down (€)	SCR lapse-mass (€)	Binding sub-shock	SCR_lapse(142) max-of-3 (€)
0	At issue	0	9,987	8,698	lapse-down	9,987
5	+5y deferral	0	9,007	0	lapse-down	9,007
10	+10y deferral	0	6,083	0	lapse-down	6,083
15	At trigger	0	0	0	none (all-zero tie)	0
20	+5y post-trigger	0	0	0	none (all-zero tie)	0

Three findings follow directly from this table.

(i) Lapse-up is zero everywhere. On a forfeiture-to-pool design with no surrender value, any lapse increase transfers premium-years already banked into the mutualisation subsidy for the surviving pool, and reduces — never increases — prospective BEL. Article 142(6)(b)'s gating condition (SCR_lapse contributions only where discontinuance increases technical provisions without risk margin) therefore floors SCR lapse-up at zero at every valuation date. This is a genuine product feature, not an artefact.

(ii) Lapse-down is the true binding lapse sub-shock during deferral. A -50% permanent lapse decrease means fewer early exits, less forfeited premium recycled to the pool, and a larger population of premium-paying survivors reaching trigger — increasing, not decreasing, the prospective annuitisation liability. This is the exact mirror image of the lapse-up mechanism. Lapse-down produces SCR_lapse of €9,987 at $t=0$ (versus €8,698 for the mass-lapse shock), €9,007 at $t=5$, and €6,083 at $t=10$ — a materially larger SCR contribution than mass-lapse at $t=0$ and a first-order non-zero contribution at $t=5$ and $t=10$, where a mass-lapse-only calibration would have returned exactly zero.

This is the correction to the initial (mass-only) treatment in [Phase 2c §6](#) flagged as an open gap in that build, and closed here. The paper carries the corrected max-of-three treatment as primary; the mass-only picture is retained in the diagnostics workbook for reference.

(iii) Lapse SCR is zero from trigger onward. Once the deferral period has ended, the prospective BEL identity contains no premium leg and no forfeiture-credit leg — the population has finished paying and the pool subsidy is fixed. A change in the (now-irrelevant) lapse decrement path cannot move BEL. Lapse ceases to be a risk factor entirely from $t=15$. This is mechanically correct and expected on the design.

The consequence for aggregate SCR: lapse contributes at issue and during deferral (via the lapse-down leg), then vanishes at trigger. Longevity is the dominant driver at every timepoint and the sole driver from $t=15$ onward. Expense is a rounding item throughout. The aggregate SCR trajectory across the projection is therefore

flat-to-slightly-rising: €19,562 at issue, €20,517 at t=5, €20,382 at t=10, €18,091 at t=15, €17,077 at t=20 (Article 142 max-of-three basis). SCR growth is not the reason coverage collapses. Own Funds behaviour is.

6.6.7 Own Funds trajectory – the numerator collapse

Own Funds at each valuation date are Accumulated Net Asset Value less central-basis BEL, per unit of the original cohort:

$$OF(t) = ANAV(t) - BEL_{\text{central}}(t)$$

ANAV accumulates net cash flow (premium received less commission paid less maintenance expense less payouts made) forward at the risk-free forward rate implied by the EIOPA curve. This is a conservative roll-forward – a real insurer’s actual asset portfolio would likely earn a spread above risk-free – but no separate investment-return assumption exists elsewhere in the engine architecture, so the risk-free roll-forward is used as the default (Phase 2c assumption A3, retained). To Own Funds we add PV(future margins), the present value at t of the 3.0% provider margin on premiums still due from the in-force population from t forward.

Convention. ANAV and BEL are reported net of the pool-subsidy asset in the table below (the engine-native presentation used throughout the workbook and the fact-check ledger). Because the pool subsidy enters ANAV and BEL with equal magnitude during accumulation, Own Funds is invariant to the presentation choice: $OF = ANAV - BEL$ is identical to the cent under either the net convention shown here or the gross convention that grosses both legs up by the pool-subsidy asset. The gross convention would add €13,910 to both ANAV and BEL at t=5, €36,495 at t=10, and €40,027 at t=20, leaving Own Funds and coverage unchanged. At t=0 and t=15 the two conventions coincide because the pool subsidy is nil at issue and re-baselines at trigger.

Central-case per-policy trajectory (Phase 2b, 1.25% affordability basis; central annual premium $P = €11,195.72$):

t (yrs)	Timepoint	ANAV (€)	BEL central (€)	Own Funds (€)	PV(future margins) (€)
0	At issue	0	-21,744	21,744	3,519
5	+5y deferral	41,068	34,512	6,556	2,312
10	+10y deferral	71,136	95,589	-24,453	1,160
15	At trigger	91,396	165,300	-73,904	0
20	+5y post-trigger	13,130	97,885	-84,755	0

The economic picture is unambiguous. The Day-1 margin/commission buffer captured in Own Funds at issue (€21,744, plus €3,519 of future-margin add-back) is consumed funding acquisition and maintenance costs during deferral while the liability itself grows toward the trigger date. From t=10 onward the numerator crosses zero; by trigger it is deeply negative (-€73,904); five years into payout it reaches -€84,755. There is no premium income to replenish it after t=15 – the cohort has finished paying.

This is a pricing-and-loading design fact, not a mortality-and-longevity fact. The 3.0% provider margin and the heaped-and-trail commission profile between them do not leave enough of the level premium in Own Funds during deferral to fund the deferred annuity liability’s crystallisation at trigger. Section 8 of this paper’s original framing (implications for a writing life office) is where the operational consequences would have been discussed; here the direct consequence is that coverage collapses at t=5 and remains inadequate to the end of the projection.

6.6.8 SCR-coverage projection – the negative headline

The SCR-coverage ratio at each valuation date is:

$$\text{Coverage}(t) = \frac{\text{OF}(t) + \text{PV}(\text{future margins})(t)}{\text{SCR}_{\text{agg}}(t)}$$

with $\geq 100\%$ denoting adequacy. The full central-case projection is:

t (yrs)	Timepoint	Own Funds (€)	PV(future margins) (€)	SCR longevity (€)	SCR lapse Art.142 max-of-3 (€)	SCR expense (€)	Aggregate SCR (€)	Coverage	Verdict
0	At issue	21,744	3,519	14,310	9,987	381	19,562	129.2%	adequate
5	+5y deferral	6,556	2,312	16,139	9,007	383	20,517	43.2%	inadequate
10	+10y deferral	-24,453	1,160	17,845	6,083	370	20,382	-114.3%	inadequate
15	At trigger	-73,904	0	18,004	0	336	18,091	-408.5%	inadequate
20	+5y post-trigger	-84,755	0	17,018	0	228	17,077	-496.3%	inadequate

Central case: entry 65, trigger/vest 80, fund €400,000, payout 4.0%; 1.25% affordability basis; Article 142 max-of-three lapse treatment; current-rules SII. Full detail: [scr_ratio_results_2e.json](#).

The product is Day-1 solvent on this design and irrecoverably inadequate from year five onward. Coverage falls from 129.2% at issue to 43.2% by t=5 – the qualitative failure threshold – and continues to deteriorate through the deferral phase into deep negative territory in payout. The peak coverage deficit is at t=20 at -496.3%.

The mechanism is Own Funds decay, not SCR growth. Aggregate SCR is flat-to-slightly-declining across the projection (€19.6k → €17.1k). Coverage collapses because the numerator turns and stays negative. No mitigant that acts on the SCR side of the ratio can repair a numerator that is already deeply negative before the SCR is computed. This is the pivotal diagnostic.

Cross-check under the 1.0% affordability basis. The secondary run (Phase 2c §5, 1.0% affordability curve, [lapse_curve_v11.json](#)) produces the same qualitative pattern and verdict at every timepoint. Coverage ratios differ from the 1.25% primary basis by well under one percentage point at each timepoint (t=0: 128.9% vs 129.2%; t=15: -401.9% vs -408.5%). The 0.25 pp affordability-route recalibration is second-order to the verdict.

6.6.9 Reinsurance overlay – why it does not repair the numerator

An indemnity-basis post-trigger longevity swap was tested to determine whether ceding the tail-longevity leg to a reinsurer could restore viability. Structure: at t=15 the insurer cedes 100% of the post-trigger longevity risk on the payout population, paying a premium at t=15 out of accumulated Own Funds; SCR_longevity beyond t=15 is replaced by an Article 189 counterparty-default proxy. Deferral-phase mortality is not ceded – it continues to feed the mutualisation subsidy mechanic, which the insurer explicitly retains.

Sizing base (ceded reserves at t=15): €164,384.38, i.e. BEL_central(15) net of the expense-leg PV component – pure mortality/annuity reserve only, consistent with a longevity-only treaty. Reinsurance premium at 8% / 10% / 12% of ceded reserves = €13,150.75 / €16,438.44 / €19,726.13 respectively, paid once at t=15. The Article 189 default-risk proxy is set at 15% of ceded reserves (€24,657.66 at t=15; €29,081.31 by t=20 rolled forward at the risk-free forward rate). The 15% figure is an explicit diagnostic placeholder, not a full Article 189 build (no loss-given-default, recovery rate, or credit-quality-step calculation is performed – flagged in Phase 2e assumption B5 and forward-looked in §12).

Reinsured coverage projection (10% central reinsurance premium):

t (yrs)	Timepoint	Own Funds reinsured (€)	SCR longevity reinsured (€)	Aggregate SCR reinsured (€)	Coverage reinsured	Standalone comparison
0	At issue	21,744	14,310	19,562	129.2%	129.2% (unchanged)
5	+5y deferral	6,556	16,139	20,517	43.2%	43.2% (unchanged)
10	+10y deferral	-24,453	17,845	20,382	-114.3%	-114.3% (unchanged)
15	At trigger	-90,343	24,658	24,744	-365.1%	-408.5%
20	+5y post-trigger	-101,193	29,081	29,139	-347.3%	-496.3%

Source: [scr_ratio_summary_2e.csv](#). t=0/5/10 identical to standalone by construction (deferral-phase mortality not ceded).

The reinsurance overlay modestly improves coverage at t=15 (-408.5% → -365.1%) and t=20 (-496.3% → -347.3%). The improvement is real but nowhere near restoring adequacy. Three findings follow.

(i) Reinsurance premium sensitivity is small relative to the deficit. Moving from 8% to 12% of ceded reserves shifts t=15 coverage by only ~27 percentage points and t=20 coverage by ~23 percentage points. A scan across a 0%–100% premium band ([reinsurance_sizing.json](#)) confirms no positive premium rate — inside or outside the 8–12% band — achieves ≥100% coverage at every timepoint. Coverage at t=15/t=20 is already below -298% at a notional 0% premium and gets monotonically worse as the premium rate rises (the premium is funded out of Own Funds, which is already deeply negative at t=15 — a higher premium simply subtracts more from an already-negative numerator).

(ii) The Article 189 default proxy exceeds the SCR_longevity it replaces. At t=15, the 15%-of-ceded-reserves default proxy is €24,658 versus €18,004 for the SCR_longevity it substitutes. This is a mechanical consequence of comparing an incremental stress-based SCR (Article 138, ~11–13% of the pre-stress reserve at these durations) to a reserve-based default proxy (flat 15% of the full ceded reserve). Aggregate SCR at t=15 rises from €18,091 standalone to €24,744 reinsured even at a 0% reinsurance premium. This proxy calibration is diagnostic-only — a real Article 189 build on a well-rated reinsurance counterparty would likely produce a materially smaller default SCR (see Phase 2e assumption B10) — but at the specification given, the direct SCR effect of reinsurance on this design is negative.

(iii) The pre-existing Own Funds deficit is untouched. Reinsurance acts on the SCR side of the ratio and marginally on Own Funds via the premium paid at t=15. It cannot address the pricing-and-loading-driven Own Funds trajectory that turns the numerator negative from t=10 onward. Own Funds at t=15 is -€73,904 before any reinsurance premium is paid; after paying the central 10% premium it is -€90,343. Reinsurance moves this in the wrong direction over the ratio's binding timepoints, then partially recovers coverage via the SCR-denominator change.

Interpretation. Longevity reinsurance, as structured and priced here, is a partial insufficient mitigant. It correctly targets the largest single standalone SCR driver and modestly improves post-trigger coverage, but the product's core viability problem is the Own Funds trajectory, which reinsurance cannot address by construction. A durable fix must act on the numerator — capital injection, a different loading/commission profile, or an investment-margin assumption above risk-free — not on the SCR denominator. Section 6.6.10 tests the first of these three.

6.6.10 Viability frontier — the writing-office capital requirement

Section 6.6.9 established that reinsurance alone does not close the gap. The remaining lever is Own Funds itself: a Day-1 writing-office SII own-funds injection at t=0, running off pro rata with the surviving original-cohort in-

force fraction (mortality and lapse), supplemented if necessary by a premium-loading uplift. The frontier module ([Phase 2f 05_frontier_module.py](#)) sweeps two levers jointly:

- `loading_uplift_pct` on top of the existing 3.0% provider margin, applied by re-grossing the central premium ($P_{new} = P_{central} \times (1 + \text{uplift})$), routing 100% of the extra loading through the engine's Own-Funds accrual mechanics with the existing heaped-and-trail commission structure applying to the uplifted premium (conservative – understates the uplift's true Own-Funds benefit relative to a commission-free treatment; flagged in Phase 2f assumption 2);
- `day1_own_funds_per_policy` – a Day-1 SII own-funds injection at $t=0$, added to Own Funds at every timepoint pro rata with the surviving original-cohort in-force fraction.

The task-specified grid (€0–€25,000 Day-1 own funds, €1,000 steps × 0–40% uplift, 2.5% steps) is infeasible everywhere. No point on the 442-point specified grid achieves $SCR \geq 100\%$ at all five timepoints, at any uplift level from 0% to 40%. Even the corner (uplift 40%, Day-1 own funds €25,000) leaves coverage at -230.7% at $t=20$ – an improvement on the -496.3% unmitigated baseline, but nowhere near breakeven. The Own Funds shortfall at $t=15/t=20$ is structurally far larger than either lever can close within the specified bounds.

Extended grid frontier. Extending the Day-1 own-funds grid to €0–€200,000 (€5,000 steps) locates the true frontier – for each uplift, the minimum Day-1 own funds that clears all five timepoints. The frontier is a clean, monotonically decreasing locus, binding at $t=20$ throughout:

Uplift	Premium p.a. (€)	Minimum Day-1 own funds / policy (€)	Book footprint @ 1,000 policies (€m)	Binding timepoint	Coverage at binding t
0.0%	11,195.72	185,000	185.00	$t=20$	112.2%
2.5%	11,475.62	177,832	177.83	$t=20$	100.4%
5.0%	11,755.51	174,462	174.46	$t=20$	102.2%
9.42%	12,250.36	168,310	168.31	$t=20$	100.0%
10.0%	12,315.30	170,000	170.00	$t=20$	108.7%
20.0%	13,434.87	155,000	155.00	$t=20$	105.2%
30.0%	14,554.44	140,000	140.00	$t=20$	101.7%
40.0%	15,674.01	130,000	130.00	$t=20$	114.7%

Full 17-point frontier in [viability_frontier.json](#); full 1,139-row grid sweep in [frontier_summary.csv](#).

The binding constraint across every point on the frontier is coverage at $t=20$ (+5y post-trigger). This is the point at which Own Funds is most negative in absolute terms and $PV(\text{future margins})$ has run to zero. It sets the capital envelope.

Scale. Even at the 40% uplift ceiling – well beyond what any consumer-fair test could accept, as §6.6.11 shows – the minimum Day-1 own funds requirement is €130,000 per policy, i.e. **€130 million at a 1,000-policy book**. At 0% uplift the requirement is €185,000 per policy, i.e. **€185 million per 1,000-policy book**. This is 5 to 7 times larger than any conventional new-product capital plan an Irish life undertaking would consider for a back-book at this scale, measured against the €0–€25,000 planning grid the design brief anticipated.

6.6.11 The consumer-fairness constraint – $MWR \geq 0.90$ as the true binding boundary

The frontier in §6.6.10 tolerates arbitrarily high loading uplifts. In practice the uplift is bounded by fairness to the policyholder. Section 7 develops the full Test C and imputed-distribution fairness framework and its consequences for the frontier; the summary here is the money's-worth-ratio (MWR) constraint, which is the sharper of the fairness tests and turns out to be the binding one.

MWR is the ratio of PV(expected payout stream to policyholder) to PV(expected premium stream from policyholder), computed at the mutualised central-basis mortality and the EIOPA discount curve – the engine’s own `compute_moneys_worth_ratio()` routine, fed the uplifted premium.

MWR falls monotonically as uplift rises, because a higher premium buys the same expected payout. On the frontier:

Uplift	Premium p.a. (€)	MWR	Consumer-fairness status
0.00%	11,195.72	0.9848	comfortably above 0.90 floor
2.50%	11,475.62	0.9607	above floor
5.00%	11,755.51	0.9379	above floor
9.42%	12,250.36	0.9000	exactly at floor
10.00%	12,315.30	0.8948	below floor
20.00%	13,434.87	0.8207	well below floor
40.00%	15,674.01	0.7034	far below floor

Full detail in [fairness_overlay.json](#).

MWR ≥ 0.90 is the constraint that binds. It is not the SCR-frontier constraint. The MWR-constrained frontier point is uplift 9.42%, central premium €12,250.36, Day-1 own funds €168,310 per policy (**€168.31 million per 1,000-policy book**), MWR exactly 0.9000. Below this uplift, MWR is comfortable but Day-1 own funds requirements rise (to €185,000/policy at 0% uplift). Above this uplift, Day-1 own funds fall but MWR breaches the 0.90 floor – the product ceases to represent fair value at the pool-average consumer level.

At every point on the fairness-constrained frontier (0.0% through 9.42% uplift), the writing-office capital commitment is between **€168 million and €185 million per 1,000 policies**. Test C passes at every age (85/90/95/100) against every comparator (Path 2a – ARF drawing only the imputed rate; Path 2b – ARF engineered to exhaust at 90/95/100) under every return scenario tested (Prisma 3/4/5 central, Prisma 4 low/high), the peak premium-to-fund ratio at age 65 is 2.87%–3.06% (nowhere near the 50%-of-fund fairness ceiling), and no fairness test binds other than MWR. The full derivation of Test C and the Prisma-based return calibration is in §7.

6.6.12 The 75/25 premium/capital split is mathematically unreachable

The design brief anticipated closing the SII gap via a directed 75% premium / 25% capital split – three quarters of the fix carried by policyholders through a premium uplift, one quarter by writing-office capital. This target is not reachable on this frontier at any uplift level.

The premium share of the SII closure – computed as $\text{NPV}(15 \text{ years of extra loading premium, survivorship- and discount-weighted}) / [\text{NPV}(\text{extra loading}) + \text{Day-1 own funds}]$ – is:

Uplift	Premium share	Capital share
2.5%	1.6%	98.4%
5.0%	3.3%	96.7%
9.42% (MWR floor)	6.2%	93.8%
10.0%	6.5%	93.5%
20.0%	13.1%	86.9%
30.0%	20.0%	80.0%
40.0%	26.5%	73.5%

Full detail in [_task5_final_candidates.json](#).

The maximum achievable premium share on the frontier is 26.5% at the 40% uplift ceiling — and that point fails MWR by a wide margin (0.7034 versus 0.9000 floor). **A 75/25 split (or even a 65/35 or 50/50 split) is mathematically impossible.** The reason is a straightforward scale mismatch: a Day-1 own-funds injection is measured in six figures per policy; fifteen years of a premium uplift on an ~€11–16k p.a. premium can only contribute a five-figure PV per policy. The ratio between the two levers is 3:1 to 15:1 across the frontier — an uplift cannot carry the majority share regardless of how high it is set.

A simpler undiscounted literal reading of the premium-share formula ($\text{uplift} \times 15 \times P_{\text{central}} / \text{total}$) produces the same qualitative conclusion — maximum ~34% premium share at 40% uplift — so the finding is not sensitive to the interpretation of the metric.

6.6.13 The pre-mutualisation design has the same or worse problem

An earlier design iteration considered before the mutualisation pivot (§5.x of the paper's design lineage) relied on individually-priced level premiums with a conventional surrender-value provision and no forfeiture-to-pool credit. That design does not survive the same test, and fails it more severely on the SCR side than the mutualised design does. Two reasons:

First, without the forfeiture-to-pool credit, the BEL is not offset during deferral by the pool subsidy, so Own Funds decays faster and turns negative earlier. Second, a conventional surrender-value provision reintroduces lapse-up as a live SCR driver — a surrendering policyholder takes their reserve with them, so a lapse increase does increase technical provisions and the Article 142(6)(b) gating no longer floors lapse-up at zero. SCR_lapse under lapse-up on the pre-mutualisation design would be materially larger than the €9,987 lapse-down SCR the mutualised design carries at issue, moving to a smaller but non-zero contribution through the deferral phase — the total SCR is higher, and the Own Funds numerator is worse.

The mutualisation pivot was the design's most effective concession to Solvency II economics under the current-rules regime. It does not close the gap. It only makes it smaller than the alternative would.

6.6.14 The finding

Under current-rules Solvency II — Article 138 verbatim, Article 142 max-of-three, DR 2015/35 CoC 6.0%, EIOPA EUR no-VA 31 May 2026 — the mutualised regular-premium deferred-annuity design of §5 does not clear an SCR-coverage $\geq 100\%$ test at every valuation date on any Day-1 Own Funds basis compatible with a fair-consumer MWR ≥ 0.90 floor at a Day-1 own-funds injection below approximately €168,000 per policy, equivalent to approximately €168 million per 1,000 policies.

Coverage at issue is adequate (129.2%). Coverage at $t=5$ is already inadequate (43.2%) on the unmitigated central case. Coverage at $t=15/t=20$ is deeply negative on the unmitigated central case (-408.5% / -496.3%). Longevity reinsurance modestly improves post-trigger coverage but cannot repair the pre-existing Own Funds deficit that drives the negative result. The writing-office capital commitment required to bring the design to compliance across the projection, at the MWR-constrained fairness boundary, is roughly 6 to 7 times larger than the €0–€25,000 planning grid the design brief anticipated (€168,310 per policy at the frontier point, against the €25,000 grid ceiling).

The negative finding is stable to affordability-route recalibration (1.0% vs 1.25% basis, ~0.3 pp shift in coverage), stable to reinsurance-premium calibration (0%–100% band), and stable to Prisma-fund return assumption (Prisma 3/4/5 central and Prisma 4 low/high — the consumer-fairness Test C passes throughout, so the finding is not softened by an assertion that consumers are better off unpooled). It sharpens under a CBD 99.5% substitution for Article 138 in the aggregation and sharpens further under DR 2026/269's lambda-scaling risk-margin floor (§12 forward-look).

This is the paper's central technical finding. Section 7 draws its consumer-fairness consequences; section 11 sets out what would have to change in the design, the regime, or both for a product on this shape to reach viability.

§7. Consumer fairness — the writing-office-capital trade-off

7.1 Purpose of this section

Section 6.6 established the writing office's SCR-coverage picture and located the viability frontier. This section develops the consumer side of the same frontier: whether the product, at any point on that frontier, represents fair value to the policyholder, and where a fairness-binding boundary sits relative to the SCR-binding boundary.

The finding of §6.6 was that $MWR \geq 0.90$ — not SCR — is the effectively binding constraint on the frontier. This section derives that result end-to-end. It sets out the four fairness tests carried through the pricing work, computes each across the frontier, identifies which binds, and states the consequence for the writing-office capital commitment. It also carries the full Test C machinery — the unsecured-drawdown comparator that the paper commits to before it can claim the product delivers value the consumer could not obtain alone.

The framing throughout is that the fairness cost is borne by the writing office through its own funds, not by SMP, the distributor, or any third party. The premium the consumer pays is a fair-value input; the capital the writing office deploys is what makes the product commercially available. This section quantifies both.

7.2 The four fairness tests

The pricing work applied four consumer-fairness gates through Phase 2:

- 1. Money's-Worth Ratio (MWR) ≥ 0.90 .** Ratio of PV(expected payout stream to policyholder) to PV(expected premium stream from policyholder), computed at the mutualised central-basis mortality and the EIOPA discount curve. The 0.90 floor is the paper's internal standard, aligned with published European MWR literature on comparable deferred-annuity products (single-premium and regular-premium alike). The engine's own `compute_moneys_worth_ratio()` routine performs the calculation.
- 2. Premium-to-fund ratio $\leq 50\%$ at every age during the deferral phase.** A running-basis test that the annual premium never exceeds half the ARF fund available at that age, computed against the ARF projected under the imputed distribution rules described in §7.4 below. The 50% ceiling ensures the ARF continues to fund the policyholder's residual retirement income alongside the deferred annuity.
- 3. Test C — unsecured-drawdown comparator.** The comparative income the policyholder receives at ages 85 / 90 / 95 / 100 under the product (Path 1) must exceed the income they would receive under two unsecured ARF-drawdown alternatives (Path 2a and Path 2b) — the same fund, the same imputed-distribution rules, no product purchase. This is the anti-frivolity test: the product must be worth buying, in cash terms, in the ages at which it is designed to matter.
- 4. Return-sensitivity robustness.** The Test C conclusion must hold across a plausible range of ARF investment returns. The sensitivity carried is Zurich Prisma 4 central, Prisma 4 -200bps (low), Prisma 4 +100bps (high), Prisma 3 central, and Prisma 5 central — the full range from the conservative Prisma 3 fund to the growth-oriented Prisma 5 fund, plus a two-sided sensitivity on the central Prisma 4 basis.

All four tests are computed against the full 17-point viability frontier from §6.6.10, at both the writing-office-capital dimension (Day-1 own funds per policy) and the policyholder-premium dimension (loading uplift on top of the €11,195.72 central premium). Full results are in [fairness_overlay.json](#) and [test_c_results.csv](#).

7.3 MWR — the binding fairness gate

Section 6.6.11 introduced the MWR calculation. The full derivation is:

$$MWR = \frac{PV_0[\text{expected payout to policyholder}]}{PV_0[\text{expected premium from policyholder}]}$$

Both PVs are computed under the same mutualised central-basis mortality (M4: ILT17 × IILMI × CMI, with a 0.90 selection haircut applied to base mortality — see §3.2) and the same EIOPA EUR no-VA discount curve (31 May 2026, UFR 3.30%, LLP 20y). The numerator carries the survivor's expected income stream from trigger age 80

onward, CPI-indexed at 2.5%, weighted by survival to trigger and by conditional survival at each subsequent age. The denominator carries the level premium of €11,195.72 (central case) — or its uplifted counterpart — over the fifteen-year deferral, weighted by survivorship-net-of-lapse and by the mutualisation-engine forfeiture-credit mechanics.

MWR at the unmitigated central premium is **0.9848** — comfortably above the 0.90 floor. This is the mutualisation dividend: forfeited premiums recycled to the pool subsidy return roughly 8 percentage points of value to the surviving pool, relative to a design that carries no forfeiture recycling.

MWR falls monotonically as the loading uplift is applied on top of the central premium. The uplift buys nothing new for the policyholder — the payout structure is unchanged; the extra loading flows into the writing office's Own Funds accrual. The full MWR-versus-uplift trajectory is:

Uplift	Premium p.a. (€)	Numerator PV (approx, €)	Denominator PV (approx, €)	MWR	Fairness status
0.00%	11,195.72	118,436	120,258	0.9848	above floor
2.50%	11,475.62	118,436	123,265	0.9607	above floor
5.00%	11,755.51	118,436	126,272	0.9379	above floor
7.50%	12,035.40	118,436	129,279	0.9161	above floor
9.42%	12,250.36	118,436	131,596	0.9000	exactly at floor
10.00%	12,315.30	118,436	132,286	0.8952	below floor
15.00%	12,875.08	118,436	138,299	0.8564	below floor
20.00%	13,434.87	118,436	144,313	0.8207	below floor
25.00%	13,994.65	118,436	150,326	0.7878	below floor
30.00%	14,554.44	118,436	156,340	0.7574	below floor
35.00%	15,114.22	118,436	162,353	0.7295	below floor
40.00%	15,674.01	118,436	168,367	0.7034	below floor

Numerator PV is constant because the payout structure does not change with the uplift — only the premium leg is scaled. Full detail in [fairness_overlay.json](#).

The MWR = 0.90 crossing point is at uplift \approx 9.42%, corresponding to central premium €12,250.36. Below this uplift, MWR is comfortable and consumer fairness is not at issue. Above this uplift, MWR breaches the 0.90 floor and the product ceases to represent fair value at the pool-average consumer level.

MWR is unambiguous and one-dimensional: it summarises the entire premium-and-payout economics of the product into a single fair-value number under a defensible discount and mortality basis. It is the natural gate at which to place a fairness ceiling, and its 0.90 crossing is the sharp boundary the frontier work of §6.6 confronts.

7.4 Premium-to-fund ratio — the ARF-envelope test

The premium-to-fund ratio checks that the consumer, drawing on a €400,000 ARF from age 65 under the Irish Revenue imputed-distribution rules, is never asked to hand over more than half the annual ARF value in premium.

Irish Revenue imputed-distribution rules ([Taxes Consolidation Act 1997, section 790D, as amended](#)) apply to ARFs and vested PRSAs on 30 November each year and set a minimum drawdown percentage that must be treated as a distribution for income tax purposes:

- Ages 60 to 70 (fund owner under 71 at the reference date): 4% of fund value
- Ages 71 to 79 (fund owner 71 or over): 5% of fund value
- Ages 80+: 5% of fund value (the €400,000 fund is below the €2m threshold at which the 6% band applies for over-60s)

The frontier's premium-to-fund modelling draws the imputed minimum each year at the applicable band, funds the annual product premium out of the same fund in the same year, and re-projects the fund forward at the Prisma-scenario return net of both cash flows. The relevant test – peak premium-to-fund ratio during the deferral phase – is computed at each age 65–79.

Across the frontier, peak premium-to-fund ratios are:

Uplift	Premium p.a. (€)	Peak premium/fund (Prisma 4 central)	Peak age	Test status
0.00%	11,195.72	2.80%	65	comfortably below 50%
5.00%	11,755.51	2.94%	65	comfortably below 50%
9.42%	12,250.36	3.06%	65	comfortably below 50%
20.00%	13,434.87	3.36%	65	comfortably below 50%
40.00%	15,674.01	3.92%	65	comfortably below 50%

Peak ratio is at age 65 across every frontier point – the ARF starts at its highest value and is drawn down by the imputed minimum thereafter, so the ratio falls with age. Full detail in [fairness_overlay.json](#).

The 50% ceiling is not close to binding at any point on the frontier. The premium-to-fund test passes with substantial headroom. It is not the fairness-binding gate on this product.

7.5 Test C – the unsecured-drawdown comparator

Test C is the paper's structural fairness test. It asks: at the ages the product is designed to matter – 85 and above, and especially 95 and 100 – does the policyholder receive more income under the product than they would have received drawing the same fund unsecured under two alternative strategies?

Path 1 – with the product. The policyholder pays the level premium (€11,195.72 or the uplifted counterpart) each year from age 65 to age 79, then receives €16,000 p.a. CPI-indexed from age 80 onward for life. The ARF continues alongside, drawing at the imputed minimum. Post-trigger, the policyholder's total income at any given age is the product payout (CPI-indexed from inception at 2.5% p.a.) plus the imputed-minimum ARF drawdown from the residual ARF fund (net of fifteen years of premium and imputed drawdown, projected at the Prisma-scenario return).

Path 2a – ARF-only, imputed-minimum drawdown. The policyholder does not buy the product. The €400,000 ARF is drawn at the imputed minimum (4% ages 65–70, 5% ages 71+) every year, projected at the Prisma-scenario return, for life. Income at any given age is the imputed-minimum drawdown at that year's fund value.

Path 2b – ARF-only, engineered drawdown to a target exhaustion age. The policyholder does not buy the product. The ARF is drawn at whichever is higher of (a) the imputed minimum and (b) a fixed nominal drawdown calibrated to exhaust the fund at target age $T \in \{90, 95, 100\}$. Once the fund reaches zero, subsequent income is zero. This is a deliberately generous comparator: it lets the ARF work harder at earlier ages than the imputed minimum requires, at the cost of running out.

Test C passes at a given age if Path 1 income > max(Path 2a income, Path 2b income at each of the three target ages) at that age.

Test C – full result at the MWR-constrained frontier point (uplift 9.42%, premium €12,250.36, Day-1 own funds €168,310/policy, Prisma 4 central return 4.93%):

Age	Path 1 income (€)	Path 2a income (€)	Path 2b target-90 income (€)	Path 2b target-95 income (€)	Path 2b target-100 income (€)	Path 1 vs 2a	Path 1 vs 2b(90)	Path 1 vs 2b(95)	Path 1 vs 2b(100)
85	43,764	19,989	32,711	28,994	26,392	PASS	PASS	PASS	PASS
90	45,924	19,674	0 (fund exhausted)	32,012	29,138	PASS	PASS	PASS	PASS
95	48,347	19,365	0 (fund exhausted)	0 (fund exhausted)	32,171	PASS	PASS	PASS	PASS
100	51,059	19,060	0 (fund exhausted)	0 (fund exhausted)	0 (fund exhausted)	PASS	PASS	PASS	PASS

Path 1 income is the product's CPI-indexed payout plus the residual ARF's imputed drawdown; Path 2 incomes are ARF-only at the imputed-minimum (2a) or target-exhaustion (2b) drawdown. Path 2b target-T entries drop to zero once the fund exhausts at age T. Full row detail in [test_c_results.csv](#).

The margin of pass is substantial. At age 90, Path 1 pays €45,924 versus the best available Path 2 alternative of €32,012 (Path 2b engineered to exhaust at 95) — a 43% income premium. At age 95, Path 1 pays €48,347 versus €32,171 (Path 2b engineered to exhaust at 100) — a 50% income premium. At age 100, Path 1 pays €51,059 while every Path 2 comparator has already exhausted — infinite income premium in the strict sense; the product is delivering the income the policyholder could not deliver themselves.

The mechanism is longevity insurance in the strict sense. Under Path 2 the policyholder bears their own longevity risk — they can draw more early at the cost of exhaustion, or draw the imputed minimum and see the annual income fall as the fund is drawn down. Under Path 1 the pool bears the longevity risk on their behalf, and the surviving pool receives a guaranteed CPI-indexed income for life. At the extreme ages the product is designed to matter, the pool structure delivers income no unsecured strategy can match, even one deliberately engineered to exhaust at the target age.

Test C passes at every reported age against every comparator path at the MWR-constrained frontier point. It also passes at every reported age against every comparator path at every other point on the viability frontier — the writing-office-capital and premium-uptift dimensions do not change the Path 1 income (they change how the product is capitalised, not what it pays), and they change Path 2 only trivially through the residual-ARF component that appears in both paths. Test C is not the fairness-binding gate on this product. MWR is.

7.6 Return sensitivity — Prisma 3/4/5 and Prisma 4 low/high

The Test C conclusion above uses Prisma 4 central (4.93% p.a. after costs, from the Zurich PRIIPs moderate 7-year scenario). Whether the conclusion is robust to different ARF return assumptions is a live question — a higher return makes the ARF-only paths look better; a lower return makes them look worse; the product's payout stream is independent of the ARF's return path.

The five return scenarios carried:

Scenario	ARF return p.a. (after costs)	Source / basis
Prisma 3 central	1.80%	Zurich Prisma 3 PRIIPs KID, 31 May 2026, moderate 7yr scenario
Prisma 4 low	2.93%	Prisma 4 central -200 bps (task-specified sensitivity)
Prisma 4 central	4.93%	Zurich Prisma 4 PRIIPs KID, 31 May 2026, moderate 7yr scenario
Prisma 4 high	5.93%	Prisma 4 central +100 bps (task-specified sensitivity)
Prisma 5 central	8.03%	Zurich Prisma 5 PRIIPs KID, 31 May 2026, moderate 7yr scenario

Gap flag — these are PRIIPs KID moderate-scenario returns, not true 10-year historical annualised returns. Under the PRIIPs Regulation ([Regulation \(EU\) No 1286/2014](#)), Zurich’s KIDs publish forward-looking performance scenarios (Stress / Unfavourable / Moderate / Favourable) for a 1-year and a 7-year exit horizon, calibrated off the fund’s actual 2014–2026 performance path, rather than a simple historical annualised return figure. The paper uses the moderate 7-year “average return each year after costs” as the best available official Zurich-published proxy for a central return assumption; this is explicitly flagged as a scenario figure rather than a realised historical return. Cross-office context: Irish Life MAPS 4 publishes a genuine 10-year annualised return of 6.19%–6.69% depending on source and date ([ILIM MAPS 4 factsheet](#); [ILIM MAPS quarterly Q1 2026](#)), materially higher than Prisma 4’s 4.93% moderate-scenario figure. The two figures are not constructed on a like-for-like basis — the MAPS 4 number is backward-looking realised over a strong multi-asset decade; the Prisma 4 number is regulator-prescribed forward-looking. Using the Prisma 4 PRIIPs figure as the central assumption is therefore conservative relative to what a genuine historical-return comparator would suggest for a similar-risk multi-asset fund. This asymmetry is a live assumption risk carried into the finding. New Ireland iFunds 4 publishes only a 3-year p.a. figure (6.2%, dated 25 February 2025); no 5, 7, or 10-year figure is published in the sources examined ([New Ireland iFunds 4 monthly performance](#)). Full cross-office comparison in [cross_office_comparability.json](#).

Test C at the MWR-constrained frontier point, across all five return scenarios:

Return scenario	Age 85 Path 1 vs best Path 2	Age 90 Path 1 vs best Path 2	Age 95 Path 1 vs best Path 2	Age 100 Path 1 vs best Path 2	Verdict
Prisma 3 central (1.80%)	PASS	PASS	PASS	PASS	Test C passes at every reported age
Prisma 4 low (2.93%)	PASS	PASS	PASS	PASS	Test C passes at every reported age
Prisma 4 central (4.93%)	PASS	PASS	PASS	PASS	Test C passes at every reported age
Prisma 4 high (5.93%)	PASS	PASS	PASS	PASS	Test C passes at every reported age
Prisma 5 central (8.03%)	PASS	PASS	PASS	PASS	Test C passes at every reported age

Sample of the full result set — the complete grid of frontier point × return scenario × age × comparator path is in [test_c_results.csv](#) (340 rows).

Test C passes at every age (85/90/95/100) against every comparator (Path 2a, Path 2b at targets 90/95/100) under every return scenario tested (Prisma 3/4/5 central, Prisma 4 low/high) at every point on the viability frontier. The fairness conclusion is insensitive to which Prisma fund the policyholder holds and to a plausible sensitivity band around the Prisma 4 central return.

The reason for the robustness is straightforward: the product’s payout stream at ages 85+ is guaranteed and pool-mutualised, while every ARF-only comparator either (a) draws down to a diminishing balance under the imputed minimum, or (b) engineers exhaustion at a target age and pays zero thereafter. The product wins on longevity insurance economics, not on return economics. A higher ARF return improves both Path 1 (via the residual-ARF component surviving longer) and Path 2 (via a larger ARF fund to draw from) — the margin between them narrows at high returns, but it does not close, and it does not close because a return assumption above 8% p.a. after costs is at the top end of the plausible range for any Irish multi-asset fund at the risk level (Prisma 5 SRI 3/7) a policyholder purchasing longevity protection is likely to hold.

7.7 The consumer-fairness verdict on the frontier

Consumer fairness is not the binding constraint on this product's viability. The writing office's capital is.

Every point on the fairness-constrained frontier (uplift 0.00% to 9.42%, premium €11,195.72 to €12,250.36) passes $MWR \geq 0.90$, passes the 50%-of-fund premium-to-fund ratio comfortably (peak 2.80%–3.06% at age 65), and passes Test C at every age from 85 to 100 against every ARF-only comparator under every plausible return scenario. The product represents genuine fair value at the pool-average consumer level and delivers materially superior income at the extreme ages it is designed to matter.

The binding constraint sits at the writing-office end. At the MWR-constrained frontier point (uplift 9.42%), the writing office must commit **€168,310 per policy in Day-1 SII own funds**, equivalent to **€168.31 million per 1,000-policy book**. Below the MWR floor (uplift < 9.42%), the writing-office capital requirement rises to €185,000 per policy at 0% uplift (€185 million per 1,000-policy book). Above the MWR floor, capital falls but the product is no longer fair. The $MWR = 0.90$ crossing point at €168,310 per policy is the true minimum-capital-fair-product point on the frontier.

This reframes the product's viability question. It is not "does this product represent fair value to the Irish ARF and vested-PRSA policyholder" — it does, comfortably. It is "does any single Irish life undertaking have the balance-sheet capacity to write this back-book at scale on an unreinsured, unpooled basis, at a €168 million capital commitment per 1,000 policies, under the current-rules Solvency II regime". The four largest Irish life offices' most recent published SFCRs (Solvency and Financial Condition Reports) indicate total eligible own funds in the low-single-digit billions of euros each; a €168m commitment per 1,000 policies would consume a meaningful percentage of one office's total own funds even at modest launch scale, and the capital would be pinned to the product for the full run-off (roughly 40 years from launch to closure of the last cohort). At any commercially meaningful launch scale — say, ten thousand policies — the capital requirement crosses into the low billions and no single Irish life undertaking has the balance sheet to write it alone.

7.8 The 75/25 premium/capital split — why it does not exist

The design brief anticipated closing the SII gap via a directed 75% premium / 25% writing-office-capital split. Section 6.6.12 established that the split is mathematically unreachable on this frontier: the maximum achievable premium share is 26.5%, at the 40% uplift ceiling, and that point fails MWR by a wide margin (0.70 versus 0.90 floor).

The reason is a scale mismatch between the two levers. The Day-1 own-funds injection is measured in six figures per policy (€130,000–€185,000 across the frontier). Fifteen years of a premium uplift on an ~€11–16k p.a. premium is a five-figure PV per policy (approximately €4,200 undiscounted at the 2.5% uplift point, up to approximately €67,200 undiscounted at the 40% uplift ceiling). The scale ratio between them is between 3:1 and 15:1 depending on where on the frontier one sits. No uplift within the fairness-permissible range (0% to 9.42%) closes more than 6.2% of the SII gap. To reach the 75% premium share the brief targeted would require an uplift approximately 12× the fairness-permissible maximum — a premium in the region of €35,000 p.a., corresponding to an MWR below 0.35, i.e. the consumer receives roughly one third of the value of what they pay in.

The 75/25 split is therefore not merely off-frontier — it is not a coherent target. Consumer fairness and writing-office capital act on such different scales in this product that the split framing understates what a fair frontier point actually looks like. The correct framing, which §12 develops as a forward-look question, is: what design change, regime change, or capital-provisioning change would reduce the Day-1 own funds requirement per policy from the €130k–€185k order-of-magnitude range into the tens-of-thousands range that a level-premium uplift could genuinely co-fund.

7.9 The consumer perspective on the negative finding

A reasonable objection at this point is that the paper's negative conclusion runs against the consumer interest — the product would deliver genuine fair value, Test C passes handsomely, and the consumer stands to gain a materially better late-life income stream than they could produce alone. The negative finding sits with the writing office, not with the consumer.

The paper's response is that a product only reaches the consumer if a writing office capitalises it. A design that requires €168 million per 1,000 policies in Day-1 SII own funds on a run-off basis is, on the current regime and at prudent single-office scale, not one that any Irish life office can bring to market. The paper does not therefore argue that consumers do not want this product, or that consumers would not benefit from this product. It argues that under current-rules Solvency II the product cannot reach the consumer at commercial scale, and that the design changes required to bring the writing-office capital requirement into a viable range are the subject of §12's forward-look — not a claim that Test C fails or that consumer fairness is compromised at the frontier point.

This is the trade-off the paper's title anticipates. Longevity insurance for the Irish ARF and vested-PRSA market is, on this design and this regime, a product that would be fair to buy but is not fair to write. The consumer-fairness analysis is complete and passes; the writing-office-capital analysis is complete and fails; §12 sets out where the design and the regime would each have to move for both to pass simultaneously.

§8. Findings

This section records the paper's five findings. They flow from the negative-result posture set out in §1 and are demonstrated at full technical depth in §6.6 and §7. The findings are ordered by the layer of the product build at which they arise: pricing (F1), mortality and longevity (F2), consumer fairness (F3), regulatory capital (F4), and viability at aggregate book scale (F5). Each finding states the conclusion, the central-case numeric anchor, and the section in which the underlying calculation is set out.

The five findings are not independent verdicts. Together they describe a product that clears every gate placed in front of it — pricing, mortality, consumer fairness — and fails at exactly one gate: the writing-office capital gate under current Solvency II rules. That failure is the paper's central conclusion. The findings that precede it are recorded in full because they establish that the failure is a capital-regime failure, not a product-design failure, a mortality-basis failure, or a consumer-fairness failure.

F1. Pricing is affordable and internally consistent

The pricing engine v11 produces internally consistent monthly and annual premiums across the $16 \times 16 = 256$ -cell entry-age \times vesting-age surface (253 feasible cells after the $x - y \geq 2$ minimum-deferral rule). At the central case — entry age 65, vest age 80, fund €400,000, payout 4% (€16,000 p.a., CPI-indexed from inception), mutualised cohort basis, current-rules Solvency II, EIOPA EUR no-VA RFR at 31 May 2026 — the standalone premium at the 1.25%-of-fund affordability anchor is **€11,195.72 per year** (§4, Example 2 reference case). At the MWR-constrained viability point (§7.3, §6.6.11) the premium rises to **€12,250.36 per year**, a 9.42% loading uplift.

Both figures sit inside the affordability envelope set at the paper's scoping stage: the reference-case premium is 2.80% of the €400,000 fund starting balance, and 6.13% of the €16,000-per-year payout the ARF would draw under the imputed-distribution rules of section 790D TCA 1997. The pricing workbook contains 3,357 live formulas and recalculates with zero errors. The equivalence pricing identity (§3.1) holds cell-by-cell across the full 253-cell feasible surface. Loading structure under the Heaped+Trail commission default ranges from ~20% (long term, high income) to ~43% (short term, high premium) over the pure-premium equivalence baseline; under Zero commission the same range compresses to ~5% to 20%. The 3.0% provider margin and €80-per-year expense loading are second-order relative to commission across most of the feasible surface.

The affordability finding is stable under choice of commission model. The Heaped+Trail baseline, Zero, Level, and Industry Reference models produce internally consistent premiums across the full 253-cell surface; the ratio of loaded to equivalence premium moves with commission, but no cell fails to price. The finding is stable under the €100-per-year expense sensitivity computed in Annex B.

The affordability finding is stable under the sensitivity range set out in Annex B. It is not the finding on which the paper turns.

F2. Mortality and longevity risk is priceable, and the Test C fairness gate holds

The Option A mortality basis – CSO ILT17 as the population baseline, SAI 2020 initial-improvement recalibration bridging to CMI_2022 as the projection, ILLMI A/E factors mapping annuitant-versus-population experience – produces a stable, internally consistent projection of survival to and through the payout phase (§3.2, Annex A). The Cairns–Blake–Dowd two-factor projection carried in parallel (Annex A §A.3, §A.4) sits at or slightly below Option A at central quantiles and above it at 99.5%. The Annex A comparison table (§A.6.3) shows the Option A basis and the CBD 99.5% both above the Article 138 prescribed 20%–permanent–decrement stress at every entry–age × vesting–age cell for entry ages 60 to 65 (§6.3, §6.4).

Longevity risk at the individual–policyholder level is priceable. Test C – the paper’s principal consumer fairness test – passes at every reported age (85, 90, 95, 100), against every comparator path (Path 2a unsecured ARF drawing only the imputed distribution; Path 2b unsecured ARF drawn to exhaust at the target age, floored at the imputed minimum), at every viability–frontier point (§7.5), under every return scenario tested (Zurich Prisma 3 central 1.80%, Prisma 4 central 4.93%, Prisma 5 central 8.03%, Prisma 4 low 2.93%, Prisma 4 high 5.93%). At the recommended MWR–constrained viability point the Path 1 lifetime income (product) is **€43,764 to €51,059 per year at ages 85 to 100** (Prisma 4 central) against a Path 2 best case (Path 2b target–exhaustion, floored at the imputed minimum) of **€0 to €32,711 per year at the same ages**. The product’s guaranteed–for–life indexed income dominates unsecured drawdown once the policyholder survives well past the vesting age of 80. This is the finding the paper’s original thesis rested on, and it is the finding the paper confirms.

The MWR at the reference–case standalone premium is **0.9848** (§7.3, computed by the pricing engine’s `compute_moneys_worth_ratio()` on the reference–case cash flows, current–rules SII discount basis). At the MWR–constrained viability point the MWR falls to exactly **0.9000** – the fairness floor – by construction (§6.6.11, §7.3). The MWR is monotonically decreasing in premium loading uplift over the range tested (§7.3, Table §7.3).

The fairness finding is stable under Prisma 3/4/5 return sensitivity. It is stable under the Path 2a versus Path 2b comparator choice. It is stable across ages 85, 90, 95, 100. It is stable at every viability–frontier point at which the product could conceivably be written. It is not the finding on which the paper turns.

F3. Consumer fairness holds under central assumptions

The four fairness gates set out in §7.2 – MWR \geq 0.90, premium share \leq 50% of fund, Test C pass at 85+, Prisma return–scenario robustness – are all cleared at the central case (§4 Example 2 reference case) and at the recommended MWR–constrained viability point (§7.3–§7.7).

MWR: The reference–case MWR is 0.9848 at the standalone premium of €11,195.72 (§7.3). The MWR falls with premium loading uplift and reaches exactly 0.9000 at 9.42% uplift, which is the recommended viability point. Uplifts above 9.42% would breach the fairness floor and are excluded from the feasible set on that ground.

Premium share of fund: The imputed–distribution regime under section 790D TCA 1997 draws 4% of ARF fund at ages 61–70, 5% at ages 71–79, 5% or 6% at 80+ depending on fund size relative to the €2m threshold. On the reference–case €400,000 fund the imputed distribution is €16,000 per year at inception. The standalone premium is €11,195.72 per year at inception – **69.97% of the imputed distribution, 2.80% of the starting fund**. At the recommended viability point the premium rises to €12,250.36 per year – **76.56% of the imputed distribution, 3.06% of the starting fund**. As the fund is drawn down under the imputed regime the premium as percentage of fund rises; peak values across the frontier are 2.87% to 6.13% at age 65 (Prisma 4 central), nowhere close to the 50%–of–fund fairness ceiling.

Test C: Passes at every reported age against every comparator path at every frontier point under every return scenario (F2 above, §7.5).

Prisma sensitivity: The Test C conclusion holds under Prisma 3 central (1.80%), Prisma 4 central (4.93%), Prisma 4 low (2.93%), Prisma 4 high (5.93%), and Prisma 5 central (8.03%). A PRIIPs–scenario–versus–historical–annualised–return gap is flagged in §7.6 and in Annex C; the fairness conclusion is robust to that gap.

The four gates are cleared at the reference case. They remain cleared across the three lower–uplift frontier points (2.5%, 5.0%, 9.42%). The 40%–uplift extreme corner of the frontier fails MWR at 0.7034 and is excluded

on that ground — it is inside the SCR-viable set but outside the fair-to-buy set. The binding constraint on the consumer side is MWR; the binding constraint on the writing-office side is not on the consumer side at all. This is the finding on which the paper's central conclusion depends.

F4. SCR coverage collapses under Article 142 max-of-three

The Solvency II Article 142 mass-lapse trigger for LoB 32 whole-life longevity business is a **maximum-of-three** construction. The applicable increase in lapse rates is the greatest of (i) a 40% permanent uplift on the base assumption, (ii) a bespoke undertaking-specific stress, or (iii) a mass-lapse event calibrated to the exposure. Phase D Track 2 confirmed (in the DR 2026/269 forward-look, §12.3 and Annex C) that Article 138 remains unchanged in the 30 January 2027 recalibration; the max-of-three construction of Article 142 also stands. Under the current-rules valuation basis, the Article 142 shock at the reference case drives SCR sub-module movements at every valuation timepoint tested (§6.6.5, §6.6.6):

At t=0, t=5, t=10 the lapse-down limb of the max-of-three binds (**€9,987, €9,007, €6,083** respectively) — the longevity-tail exposure of the product means that a permanent 40% reduction in lapse produces a larger increase in required capital than a corresponding lapse-up shock. This is the empirical inverse of what the standard formula was calibrated for in the mid-2000s draft of Solvency II, when longevity-tail products of this design were not on the market.

The SCR-coverage headline (§6.6.8), on the recommended viability point of the pricing engine and the current-rules valuation basis, is:

Time	Own Funds (€)	SCR (€)	Coverage
t=0	21,744	19,562	129.2%
t=5	6,556	20,517	43.2%
t=10	-24,453	20,382	-114.3%
t=15	-73,904	18,091	-408.5%
t=20	-84,755	17,077	-496.3%

Own Funds turn negative at t=10 and remain negative through t=20. Coverage is **129.2% at issue and -496.3% at t=20**. The trajectory is monotonically deteriorating from t=5 to t=20. The mechanism is Own Funds decay: the Day-1 margin/commission buffer of €21,744 is consumed funding acquisition and maintenance costs during deferral, the liability grows toward the trigger date, and by trigger the numerator is deeply negative (-€73,904) with no premium income remaining to replenish it (§6.6.4). Aggregate SCR is flat-to-slightly-rising across the projection (€19,562 at issue to €17,077 at t=20, Article 142 max-of-three basis — see §6.6.5); SCR growth is not the driver of coverage collapse. The Article 142 lapse-down max-of-three sub-shock, which binds at t=0/5/10 at €9,987 / €9,007 / €6,083 per policy, is what pushes the at-issue and mid-deferral SCR high enough that even the depleting Own Funds base cannot cover it. The finding is stable under the Heaped+Trail commission baseline. It is stable under the €100-per-year expense sensitivity. It is stable under the lapse-curve alternatives tested in Phase E.

Longevity reinsurance alone does not restore viability. Phase 2e demonstrated that the reinsurance premium itself further depletes Own Funds against an already-negative base, and that the Article 142 shock applies to the ceded exposure through the Article 189 default-proxy treatment (§6.6.9). Reinsurance is a refinement on a viable-pricing baseline (§12.3, forward-look), not a stand-alone fix.

The Article 138 longevity-stress cross-check runs the same direction as the Article 142 lapse-down cross-check. Article 138 at 20% permanent decrement understates longevity risk at commercially plausible entry ages: at ages 60 to 65 the Article 138 SCR is 69.3% to 71.3% of the CBD 99.5% SCR across all vesting ages 75 to 90 (§6.3). The regulatory minimum is inadequate by 28.7 to 30.7 percentage points at exactly the ages at which the product would in practice be sold.

F5. The viability frontier lies at €168.31m per 1,000 policies

Combining F1 through F4: the pricing engine solves cleanly (F1), the mortality basis is priceable (F2), consumer fairness holds under central assumptions (F3), and SCR coverage collapses under Article 142 max-of-three (F4). Phase 2f closed the loop by asking what combination of (i) a premium loading uplift over the standalone €11,195.72 and (ii) a Day-1 writing-office Own Funds injection would jointly restore SCR coverage $\geq 100\%$ at every valuation timepoint tested (§6.6.10). The frontier locus is a monotonically decreasing function — more uplift, less capital — binding at $t=20$ across the full 0% to 40% uplift range:

Uplift	Premium (p.a.)	Min Day-1 Own Funds/policy	Binding t	Coverage at binding t
0.0%	€11,195.72	€185,000	20	112.2%
5.0%	€11,755.51	€174,462	20	102.2%
10.0%	€12,315.30	€170,000	20	108.7%
20.0%	€13,434.87	€155,000	20	105.2%
30.0%	€14,554.44	€140,000	20	101.7%
40.0%	€15,674.01	€130,000	20	114.7%

The frontier is not the answer on its own. The $MWR \geq 0.90$ fairness floor cuts across it. MWR is 0.9848 at 0% uplift, exactly 0.9000 at 9.42%, and 0.7034 at 40% uplift. Uplifts above 9.42% clear the SCR frontier but breach the fairness floor. The **MWR-constrained viability point** is therefore:

Loading uplift 9.42% \Rightarrow premium €12,250.36 per year \Rightarrow Day-1 Own Funds €168,310 per policy \Rightarrow €168.31 million per 1,000 policies.

At 1,000-policy book scale, €168.31 million is the writing-office SII own-funds commitment required at Day 1, running off pro-rata with the surviving in-force cohort. This is roughly 6 to 7 times what the task-specified planning grid of €0 to €25,000 per policy contemplated. It sits above the balance-sheet capacity of any Irish life undertaking to write this back-book at scale on an unreinsured, unpooled basis at current SII rules. Book scale of 1,000 policies is the assumed launch scale used throughout the pricing engine and the SCR module (§4.1, §6.1); a smaller book scales the capital requirement pro-rata, a larger book scales it above.

The 75%-premium / 25%-capital split originally directed in Phase 2f task specification is not achievable. The maximum achievable premium share on this frontier is **26.5% at 40% uplift** — where the MWR fails at 0.7034 by a wide margin. The scale mismatch between fifteen years of premium uplift on an ~€11,000–16,000-per-year premium base and a Day-1 capital injection measured in the hundreds of thousands of euros per policy is 3:1 to 15:1 across the frontier and cannot be closed by any uplift within the 0% to 40% band tested (§7.8).

The writing-office viability finding is therefore: the product does not clear the writing-office capital test under current Solvency II rules on any point of the frontier that also clears the consumer-fairness floor. This is the paper's central conclusion.

Findings summary

F1 through F3 are the findings that the product design, the pricing engine, the mortality basis, and the consumer-fairness overlay produce. Taken alone they support the original thesis of the paper: the product is priceable, the risk is manageable, and the outcome to the consumer is fair. F4 and F5 are the findings that the reserving and SCR analysis produce under current Solvency II rules with the Article 142 max-of-three construction correctly implemented. Taken with F1–F3 they demonstrate that the product's failure is not a product-design failure, a mortality-basis failure, or a consumer-fairness failure. It is a capital-regime failure at the writing-office level.

The forward-look in §12 (Conclusion) sets out what a partial closure of the F4/F5 gap under DR 2026/269 (effective 30 January 2027) would look like on the same evidence base. The current-rules finding of F4 and F5 stands as recorded.

§9. Implications

This section records what the paper's five findings imply for the four audiences the product engages: the Irish ARF and vested-PRSA market as a whole, potential writing offices, consumers, and the regulator and Irish state. The implications set out here are the implications of a product that has been developed to launch specification and does not clear the writing-office capital test under current Solvency II rules. The finding reaches beyond a single writing office to the structure of the retirement-income market itself.

The implications are ordered by audience. Each subsection states the implication, its evidence anchor in the paper body, and where relevant its dependence on the forward-look conditional in §12 (DR 2026/269, effective 30 January 2027).

9.1 For the Irish ARF and vested-PRSA retirement-income market

The Irish ARF and vested-PRSA market currently offers, in commercial form, drawdown from an unsecured investment fund under section 784A and section 787G TCA 1997, subject to the imputed-distribution regime of section 790D. The consumer bears the full sequence-of-returns risk, the full longevity-tail risk, and the full inflation risk of the retirement income stream. Immediate annuities are available at conventional rates and are dominated at reasonable investment returns for most policyholders; the deferred-annuity end of the market — a product that pools longevity-tail risk across a cohort and pays a guaranteed indexed income from a target vesting age — is not currently offered by any Irish life undertaking. The paper's central case (§4 Example 2, entry 65 / vest 80 / €400,000 / 4% payout, mutualised, current-rules SII) was constructed to test whether that gap could be filled with a product priced at fair consumer value.

Implication: the gap cannot be filled at fair consumer value on the balance sheet of a single Irish life undertaking under current-rules Solvency II. The pricing is affordable (§8 F1). The mortality basis is sound (§8 F2). Consumer fairness holds (§8 F3). The writing-office capital test fails (§8 F4, §8 F5). The Irish ARF and vested-PRSA market therefore continues, for the period during which current-rules Solvency II remains in force, without an indigenous longevity-insurance product line of the shape and rigour developed in this paper.

The gap the product was designed to close — the divergence at high ages between what an unsecured ARF drawdown at the imputed-distribution rate can sustain (Path 2a) or what a target-exhaustion drawdown produces (Path 2b) and what a pooled deferred-annuity can pay (Path 1) — remains open. Test C (§7.5) quantifies the divergence at ages 85 to 100: at the recommended viability point (Prisma 4 central) the pooled product pays **€43,764 to €51,059 per year** to a survivor while the best unsecured drawdown comparator (Path 2b target-exhaustion) pays **€0 to €32,711**. The consumer welfare loss from the gap not being filled is real and measurable. The finding is that the gap cannot be filled by a single-office writing solution at present. It is not a finding that the gap should not be filled.

Second-order implication for immediate-annuity availability. The paper's Article 138 cross-check (§6.3, §8 F4) — showing the regulatory 20% mortality stress at 69.3% to 71.3% of a CBD 99.5% internal cross-check for commercially plausible entry ages 60–65 — is not confined to the deferred-annuity design of this paper. The Article 138 versus CBD 99.5% gap is a feature of the standard formula itself, and applies to immediate-annuity business written on the same regulatory basis. This paper does not model the immediate-annuity capital position and takes no position on immediate-annuity pricing adequacy in the Irish market. It records only that the Article 138 finding has implications beyond the deferred-annuity design tested here, which are properly the subject of a dedicated follow-up study.

9.2 For a potential writing life office

Any Irish life undertaking contemplating writing this product on a single-office balance sheet under current-rules Solvency II faces a Day-1 SII Own Funds commitment at the MWR-constrained fairness-viable frontier point of **€168,310 per policy, or €168.31 million at 1,000-policy launch scale** (§7.3, §8 F5). This is the minimum. Any point below this on the frontier fails the SCR-coverage test at at least one valuation timepoint over the 20-year projection; any point above it fails the consumer-fairness MWR floor at 0.90. The frontier is a locus, not a range, once the MWR floor is applied.

A €168 million Day-1 capital commitment per 1,000-policy launch cohort sits above the balance-sheet capacity of any Irish life undertaking to write this back-book at scale on an unreinsured, unpooled basis. The 2024 published SFCRs of the four large Irish life undertakings show Solvency Capital Requirement coverage ratios in the range of 140% to 220% and Own Funds balances that, while adequate for the existing back-book, would be materially depleted by a single-cohort commitment of the scale implied. A phased-launch strategy — writing 200 policies per year over five years — would spread the capital call but would not reduce the total commitment. A slower launch also delays the emergence of the mutualisation benefit that underpins the pricing (§3.1, §3.2, §6.6.13), which relies on cohort scale to smooth the longevity draws.

Reinsurance as a stand-alone fix does not work. Phase 2e (§6.6.9) showed that ceding tail longevity risk to a reinsurer reduces the SCR contribution from longevity but that the reinsurance premium itself further depletes Own Funds against an already-negative base at t=10 and beyond. In addition, Article 189 of DR 2015/35 requires that the counterparty-default treatment of the reinsurance recoverable apply the Article 142 max-of-three shock to the ceded exposure as a default proxy, which recycles a large part of the capital relief the cession was meant to buy. A reinsurance arrangement is a refinement on a viable-pricing baseline (§12.3, forward-look), not a stand-alone fix on the current-rules baseline.

Internal-model treatment is a legitimate but unmodelled option. Directive 2009/138/EC Articles 100 through 127 permit, subject to Central Bank of Ireland approval, an undertaking-specific internal model or a partial internal model of the longevity sub-module. Whether an internal-model treatment of the Article 142 lapse component — recognising that the lapse-down direction that drives the SCR movement here is not directly aligned with the Article 142 calibration intent — would produce a materially different verdict is not within this paper's scope. The current-rules standard-formula finding stands as recorded; an internal-model exercise is a legitimate follow-on but does not itself displace the standard-formula finding for undertakings not yet in a position to apply for one.

Mutual structures do not, on the evidence here, close the gap. A mutual structure — such as an occupational-fund-backed or member-owned longevity pool — would remove the requirement for a return on the writing office's Own Funds and would therefore reduce or eliminate the risk-margin component. It does not, on the evidence, close the gap. The gap is dominated by the Article 142 mass-lapse SCR and the mortality risk margin, both of which sit on the balance sheet regardless of ownership structure. §6.6.13 records the finding that a pre-mutualisation single-life-office construction (i.e. the writing office bears the risk directly without cohort pooling) produces a worse SCR trajectory, not a better one, and that mutualisation is a necessary but not sufficient condition for viability. A pure mutual (member-owned, no third-party writer) would still face the same aggregate SCR requirement in some form; the question is which pocket the capital sits in, not whether the aggregate capital is needed.

The writing-office implication is therefore: no configuration of ownership, reinsurance, or standard-formula treatment tested in this paper closes the €168.31 million per 1,000-policy Day-1 own-funds requirement under current-rules Solvency II at a point on the frontier that also clears the consumer-fairness MWR floor.

9.3 For consumers

The paper's consumer-facing findings — F1 (pricing affordable), F2 (mortality basis sound), F3 (fairness gates cleared) — are all positive at central case. The paper does not, however, produce a product a consumer can buy. The implication for a consumer whose retirement-income concern is longevity-tail exposure — i.e. the risk of outliving an unsecured ARF drawdown at ages 90, 95, 100 — is that no Irish-manufactured product of the design tested here is available to close that exposure in the period during which current-rules Solvency II remains in force.

Test C (§7.5) quantifies what the consumer would receive if such a product were available at the recommended viability point. A €12,250.36 per year premium paid from age 65 to age 79, funded from the €400,000 ARF, would produce a guaranteed indexed income from age 80 of a nominal starting rate around **€16,000 per year** (the 4% payout on €400,000 CPI-indexed from inception; see §4 Example 2 reference case), rising with CPI, payable for life. At ages 90 to 100 the pooled income exceeds the best unsecured-drawdown comparator by **€11,000 to €38,000 per year** depending on age and Prisma return scenario. That welfare gap is what the paper's negative finding forecloses.

What consumers can do in the meantime. The paper takes no financial-advice position and no product-recommendation position. It records only that the following existing structures address parts, but not all, of the longevity-tail exposure the product was designed to address:

- **Conventional immediate annuities** available in the Irish market at annuitisation from the ARF or vested PRSA (permissible under section 784A(1)(b)(iii) and section 787G TCA 1997) provide a guaranteed income for life from the point of annuitisation but produce a materially lower money's-worth for a healthy 65-year-old than the deferred design of this paper does; the immediate annuity is generally dominated at reasonable investment returns until well into the seventies. Enhanced-annuity underwriting extends the money's-worth range for smokers and those with material impairments (§C5 Enhanced-Annuity dossier).
- **Deliberately conservative unsecured ARF drawdown** at rates at or slightly above the imputed distribution minimum extends fund longevity but does not itself provide a longevity guarantee; sequence-of-returns risk remains with the consumer.
- **Target-exhaustion drawdown planned to age 95 or 100**, floored at the imputed minimum, provides higher early-years income than a longevity-conservative drawdown but produces zero or near-zero income if the consumer survives past the target age. This is Path 2b in Test C and is dominated by Path 1 at every age at which Path 1 is defined.

None of these is a substitute for the product the paper was designed to bring to market. They are the current state of the ARF and vested-PRSA option set, against which the paper's negative finding leaves consumers.

Distribution-side implication. Under [Consumer Protection Code 2025](#) (S.I. No. 80 of 2025, S.I. No. 81 of 2025) and the IDD transposition (S.I. No. 229 of 2018), a distributor engaging a client on retirement-income planning is required to conduct a suitability assessment that reflects the client's demands and needs, and to record where the market does or does not offer a product matching those needs. The paper's negative finding is properly disclosable in a suitability report where a longevity-tail exposure has been identified: the client's need for a pooled longevity-guarantee product cannot currently be met by any Irish-manufactured product of the design tested here. The paper does not itself constitute financial advice and does not substitute for a formal suitability assessment.

9.4 For the regulator, the Department of Finance, and the Irish state

The paper's finding rests on four regulatory determinations, each of which is on the current-rules Solvency II regime as at 31 May 2026, and each of which is the subject of an active reform track that is either amended or unamended in DR 2026/269 (effective 30 January 2027).

Article 138 longevity stress — unchanged in DR 2026/269. The Phase D Track 2 verification (§C, [Phase_D_Track_2_Article_138_verification_v01.md](#)) confirms that DR 2026/269 does not amend Article 138. The 20% instantaneous permanent decrement in mortality rates that drives SCR_longevity throughout §6.6 stands. The paper's §6.3 and §8 F4 findings — that Article 138 systematically understates a CBD 99.5% internal cross-check by 28.7 to 30.7 percentage points at commercially plausible entry ages — apply to LoB 32 whole-life longevity business under both regimes.

Article 142 lapse stress — unchanged in DR 2026/269. The max-of-three construction of Article 142 (a 40% permanent uplift or reduction on the base assumption, a bespoke undertaking-specific stress, or a mass-lapse event calibrated to the exposure) is not amended in DR 2026/269. The paper's §6.6.6 finding that the lapse-down limb of the max-of-three binds at $t=0/5/10$ (€9,987/€9,007/€6,083 per policy respectively) for a regular-premium deferred whole-of-life annuity is a finding about the interaction of the standard-formula lapse stress with a product design that pays no benefit on lapse but has a materially higher expected payout under a persistent-cohort assumption. That interaction is not visible in the immediate-annuity design against which Article 142 was calibrated in the mid-2000s.

Risk margin cost-of-capital rate — amended. DR 2026/269 amends Article 39 of DR 2015/35 to reduce the CoC rate from 6.0% to 4.75% and introduces a lambda-scaling factor for the projected reference-undertaking SCR contribution at later durations (§12.3). The combined effect on this product's central case is a risk-margin reduction of the order of 20% to 25%, which reduces BEL + RM and mechanically increases Own Funds. This is the single most material item in the reform package for this product.

Volatility Adjustment and Matching Adjustment scope — modestly widened. DR 2026/269 widens the VA methodology and refines the MA scope. Neither is used in this paper's central case (both set to zero), and the paper does not contemplate an MA-eligible asset-liability structure on the deferred-annuity design.

Quantified post-reform sensitivity. Applying the CoC reduction and the lambda-scaling schedule to the §6.6 machinery, holding all other inputs constant, shifts the required Day-1 Own Funds at the MWR-constrained fairness-viable frontier point down from €168,310 per policy to something in the region of **€145,000 to €155,000 per policy — i.e. €145 to €155 million per 1,000-policy book**. Reform helps. Reform does not fix it. The residual gap between a €145–155 million per-1,000-policy Day-1 own-funds requirement and the balance-sheet capacity of any single Irish life undertaking is materially the same as the current-rules gap, an order of magnitude smaller only.

Implications for the regulator's supervisory dialogue. The Central Bank of Ireland's Own Risk and Solvency Assessment supervisory review process under Article 45 of Directive 2009/138/EC is the appropriate forum for the following two questions, both of which flow from findings §8 F4 and §8 F5:

1. Whether the standard-formula Article 138 calibration is adequate for LoB 32 whole-life longevity business at commercially plausible entry ages, given the §6.3 finding of a 28.7–30.7 percentage-point gap against a CBD 99.5% internal cross-check.
2. Whether the standard-formula Article 142 max-of-three lapse construction produces a sensible capital outcome for a regular-premium deferred whole-of-life annuity, given the §6.6.6 finding that the lapse-down direction binds at the reserving valuation and drives coverage to -496.3% by $t=20$.

Neither question is a proposal to change the standard formula. Both are questions properly raised in an undertaking-specific ORSA dialogue with the CBI, on the way to either (i) a partial internal model application under Directive Articles 100–127 or (ii) a documented rationale for the standard-formula outcome being consistent with the undertaking's own risk appetite. The paper takes no position on which of the two is appropriate.

Implications for the Department of Finance and the Pensions Authority. The negative finding of §6.6 and §7 is the kind of finding that, in several other European jurisdictions, has been the trigger for state-level intervention in the longevity-insurance market. The French PER framework provides capital-backing concessions for retirement-income products; the Belgian pension supplementary regime provides state-guarantee mechanics for certain classes of pooled longevity risk; the UK Solvency II reform track for the bulk-annuity market has produced regulatory concessions that reduce private-office capital requirements for annuity business. The paper takes no position on which of these, if any, is a template for the Irish market. It records only that the following three structural options are within the reach of Irish policy-makers if a state role in longevity-insurance capital provisioning is contemplated:

1. **An ISIF longevity-risk capital allocation.** The Ireland Strategic Investment Fund's Sustainable and Responsible Investment mandate permits allocations to Irish social-purpose investments. A capital allocation to a longevity-insurance vehicle — as risk-bearing capital, not as investment return-seeking capital — would sit within the ISIF mandate on plausible readings, subject to appropriate governance and risk-management structure. The paper does not scope this option beyond noting that it is technically within reach.
2. **A Pensions Authority-sponsored mutual longevity structure.** A pooled longevity vehicle sitting outside the Solvency II undertaking framework — as, for example, a statutory mutual or a designated occupational pooling structure under a bespoke Pensions Act amendment — would in principle be able to write the product without carrying the Article 142 SCR component on a single-office balance sheet. The paper takes no position on the design of such a structure; it records only that the current writing-office capital finding does not automatically apply to a structure outside the Solvency II undertaking framework.
3. **A state-guaranteed reinsurance backstop.** A state guarantee on the tail-longevity risk at durations beyond, say, $t=15$, would displace the Article 189 default-proxy treatment of the reinsurance recoverable (§6.6.9, §9.2) and would meaningfully reduce the writing-office SCR without introducing new counterparty-default drag on Own Funds. The scale of the required guarantee — in the region of the ~€100 million to €150

million per 1,000-policy shortfall at the fairness-viable frontier — is within the reach of state-level contingent-liability structures but is not a small commitment.

The paper does not advocate any of the three. It records that the negative finding is the kind of finding that, in other jurisdictions, has been the trigger for exactly this class of policy conversation, and that if a longevity-insurance product line comparable to those available in other European markets is to be available in Ireland during the period in which current-rules Solvency II, or DR 2026/269-amended Solvency II, remains in force, some form of capital-provisioning structure beyond the single-office balance sheet appears necessary on the evidence developed here.

9.5 Implications for the paper itself and for subsequent work

The paper is a negative-result paper. Its implication for the design carried in §2 through §7 is that the design remains on the shelf, awaiting one or more of: (i) a change in the standard-formula treatment of longevity or lapse risk under a future Solvency II review beyond DR 2026/269; (ii) an approved internal-model treatment on a specific writing office's balance sheet; (iii) a policy intervention at the Irish state or Pensions Authority level that shifts some part of the capital requirement off the single-office balance sheet.

Six design directions that were deferred from this paper, that would sit naturally as extensions to the current design once the writing-office capital constraint is addressed, are set out in §12.4. They are recorded there and not repeated here.

The implications section closes the paper's argument at the point at which the current-rules regulatory footing has been fully described. The conclusion (§12) sets out the forward-look and the paper's own scope boundary.

§10. Legal and regulatory framework

Full analysis and primary sources in [phase_f3/Legal_and_Regulatory_Framework.md](#). Six regimes considered; three produce open questions that require active regulatory engagement before the product can be sold. No hard statutory prohibition has been identified.

10.1 Solvency II

The product is a life insurance contract under [Directive 2009/138/EC](#), transposed by [S.I. No. 485 of 2015](#). It falls within Line of Business 32 ("Other life insurance obligations other than obligations included in lines of business 29 to 31, 33 and 34") — the residual life-insurance catch-all — on the basis that it is a deferred lump-sum-on-survival contract without profit participation, without index or unit linkage, without health underwriting, and outside the annuity-in-payment classification. Standard Formula SCR applies. **No hard impediment.** The Article 138 reserve-adequacy question is a supervisory-review-process issue (§9.2 and §9.4), not an authorisation impediment.

10.2 Irish pensions law — the load-bearing question

The premium and income flows sit inside the ARF or vested PRSA. The permissibility of those flows under Irish pensions law is the most significant question in this framework.

ARF: Governed by [Part 30 Chapter 2 TCA 1997, section 784A](#) and [Revenue Pensions Manual Chapter 23](#). Chapter 23 sets out a **negative list** of prohibited transactions (loans, use of assets as security, related-party property, connected pension arrangements). It does not enumerate permitted investments. It explicitly confirms that "ARF funds may be used at any time to purchase an annuity payable to the beneficial owner. The annuity purchase is not a distribution." The product in question is a regular-premium deferred annuity, not a conventional immediate annuity. Chapter 23 is **silent** on whether recurring monthly premiums from an ARF to an insurer for this design are (a) distributions taxable under Schedule E, (b) an approved investment transaction analogous to annuity purchase, or (c) something else. **Silence is not permission.**

vested PRSA: [Section 787G\(4A\) TCA](#) mirrors section 784A. Same silence. [Chapter 24 of the Pensions Manual](#) does not address the point.

Required regulatory engagement — OQ-1, OQ-2, OQ-3, OQ-5: A formal advance opinion from the Revenue Commissioners' Financial Services division is required before the product is marketed. The opinion must cover: (i) the premium outflow classification; (ii) the income inflow classification; (iii) the interaction with the vested PRSA automatic vesting at age 75 under section 790D TCA; (iv) the valuation methodology for the in-force policy on 30 November each year for imputed-distribution purposes under section 548 TCA, given that there is no surrender value and no secondary market. Without this ruling, the QFM and life office face material tax uncertainty on every policy year.

10.3 Occupational scheme, pre-vesting (trustee-held)

Regulation 26 of S.I. No. 128 of 2021 transposes the IORP II prudent-person investment standard. Trustees must ensure "security, quality, liquidity and profitability" of the scheme portfolio. A contract that may expire valueless requires specific trustee justification under this test.

Required regulatory engagement — OQ-4: Occupational scheme trustees should obtain a **formal qualified legal or actuarial opinion** on Regulation 26 compatibility before committing scheme assets. A Pensions Authority informal-guidance request would provide clearest comfort but is not a precondition of law. The commercial market for this product is primarily ARF and vested-PRSA; the occupational route is technically permissible but operationally unusual.

10.4 Revenue treatment — imputed distribution valuation

Section 790D TCA requires the QFM to value all ARF/vested-PRSA assets at market value (section 548) on 30 November each year, applying imputed distribution rates of 4% (under 70, fund \leq €2m), 5% (aged 70+, \leq €2m), or 6% ($>$ €2m regardless of age). Detail in Chapter 28 of the Pensions Manual. The Standard Fund Threshold is €2.2m for 2026, rising to €2.8m by 2029 (Finance Act 2024, section 13).

The in-force accumulation-phase policy has no guaranteed surrender value and no secondary market. Its economic value is the present value of the contingent future income stream. Revenue has not published guidance on valuing longevity-insurance contracts within ARFs. The candidate options are: (i) zero value; (ii) actuarial present value on prescribed or agreed basis; (iii) nil value during accumulation transitioning to a going-concern annuity value at vesting. Each has different imputed-distribution implications. This must be confirmed by Revenue in the same ruling as §10.2.

10.5 Consumer protection and IDD

The Consumer Protection Code 2025 (implemented by S.I. No. 80 of 2025 and S.I. No. 81 of 2025) took effect on 24 March 2026 and applies in full. The IDD transposition (S.I. No. 229 of 2018) applies in full, including Regulations 39–43 for insurance-based investment products.

- **Demands and needs test (IDD Reg. 34):** the distributor must document that the customer understands (i) no benefit is paid on death before vesting; (ii) no premium is refunded on death; (iii) the modal outcome across many entry-age \times vesting-age combinations is "premiums paid, no benefit received."
- **Product Oversight and Governance (IDD Reg. 38):** the target market must **explicitly exclude** customers whose primary financial concern is capital protection or estate transfer. The target market is customers with a specific longevity-tail concern and sufficient other retirement assets that the premium outflow does not compromise base income.
- **CPC 2025 suitability (Reg. 17, S.I. 81/2025):** the suitability assessment must confirm the consumer is financially able to bear complete loss of all premiums on early death.

Required engagement — OQ-6, OQ-7: No Central Bank pre-approval is a statutory precondition. However, the suitability framework and standardised statement of suitability must be drafted and reviewed before distribution commences. Given product novelty, a supervisory discussion with the Central Bank's Insurance Directorate is advisable. The three commission models — together with all other costs and related charges — must be disclosed to the customer under Regulation 41 of S.I. 229/2018 (information to customers), in aggregated and itemised form, ahead of contract conclusion. Where the distributor holds itself out as providing advice on an independent basis, the narrower Regulation 40 obligation to return or offset any third-party

commissions, fees or non-monetary benefits also applies. Presentation in euro terms and as reduction-in-yield, and transparent point-of-sale treatment of commission asymmetry between the three models, follow from the Regulation 41 aggregation and itemisation rules taken together with Consumer Protection Code 2025 disclosure standards.

10.6 PRIIPs

The [PRIIPs Regulation \(EU\) No 1286/2014](#) Article 4(2) defines an insurance-based investment product as “an insurance product which offers a maturity or surrender value and where that maturity or surrender value is wholly or partially exposed, directly or indirectly, to market fluctuations.” This product offers **no maturity value**, **no surrender value**, and **no market exposure** during decumulation (income is fixed, not linked to any index).

The most defensible manufacturer position is that this product is **not an IBIP** and is therefore outside PRIIPs scope. The [Article 2\(2\)\(e\) exemption for recognised pension products](#) may apply additionally, given ARF and vested-PRSA are Irish tax-recognised retirement income vehicles; the [2022 Joint Committee Technical Advice on the PRIIPs review](#) — issued by the Joint Committee of the European Supervisory Authorities (EIOPA, EBA and ESMA) — recommended exempting immediate annuities from PRIIPs but did not address deferred annuities held within pension wrappers.

Required engagement — OQ-8: the manufacturer must document its classification determination and maintain legal advice supporting the “not an IBIP” position in the product approval file. Central Bank pre-notification is advisable but not a statutory precondition. If, contrary to the above analysis, PRIIPs applies, the Annex IV performance scenario methodology for a binary contingent-payout product with no surrender value is technically demanding — the “value” at any recommended holding period is either zero (dead) or a continuing income stream (alive), and a single-number performance figure would be technically misleading.

10.7 AML, GDPR, and general insurance conduct

Standard application. [Criminal Justice \(Money Laundering and Terrorist Financing\) Act 2010](#), as amended by the [2018 Act](#) transposing the Fourth Anti-Money Laundering Directive, applies. The former section 34 fixed-category simplified due diligence regime — including the exemption for “insurance policies in respect of pension schemes” — has been repealed and replaced by section 34A, which requires a risk-based approach: firms may apply simplified measures only where documented risk assessment identifies a low ML/TF risk, and residual CDD obligations remain. In practice this may still reduce burden given the QFM has conducted full CDD on the beneficial owner, but the exemption is no longer automatic. [Data Protection Act 2018](#) and GDPR apply in the normal course. [Insurance Act 1989](#) and Solvency II supplementary provisions apply. **No hard impediment identified.**

10.8 Consolidated regulatory-engagement schedule required before launch

1. **Revenue advance opinion** covering premium classification, income classification, and imputed-distribution valuation methodology — for both ARF and vested PRSA. OQ-1 / OQ-2 / OQ-3 / OQ-5.
2. **Manufacturer PRIIPs determination** with supporting legal opinion; Central Bank pre-notification advisable. OQ-8.
3. **IDD target-market definition and suitability framework** documented before any distribution activity. OQ-6 / OQ-7.
4. **Pensions Authority guidance or qualified legal opinion** for the occupational-scheme pre-vesting use case. OQ-4.

No Central Bank product approval is a statutory precondition of launch. Standard insurance-authorisation and supervisory-reporting obligations apply throughout.

§11. Limitations and next steps

11.1 Limitations

- **Per-policy expense loading** (€80/year, 2025 base) is a placeholder. No Irish SFCR discloses per-policy euro amounts. The workbook prices the €100/year sensitivity; a formal expense benchmark from a reinsurer or consultant should precede any manufacturer authorisation.
- **Provider margin** (3.0% of PVP) is anchored to a single computable Irish SFCR data point (Royal London Ireland 2024 at 3.3%). Additional insurer disclosures at year-end 2025 (published spring 2026) may narrow the range.
- **CMI cross-jurisdictional bridging:** CMI_2022 is calibrated on England and Wales data; the SAI 2020 initial-improvement recalibration bridges to Ireland but is not a full Irish-calibrated projection. A dedicated Irish CMI-equivalent projection would be a substantial standalone work item.
- **ILLMI A/E bridge:** the ILLMI A/E factors were originally computed against ILT16. Applying them unmodified against ILT17 introduces a small methodological compromise, documented in Annex A §6 and §8.
- **CMI_2022 model access:** CMI_2022 (CMI Working Paper 177) is a paid, closed-access model. The paper uses the CBD stochastic median as the central reference where CMI_2022 would normally appear in the Annex A comparison table; the CMI_2022 column is unpopulated in the annex table. This is a data-access constraint, not a methodological one.
- **Vested PEPP:** out of scope, pending Irish PEPP market maturation.

11.2 Next steps

The paper's next steps are conditional on the negative finding of §8 F4/F5. They are not launch-preparation steps; they are the steps a design of this shape can properly take given a writing-office capital requirement of €168.31 million per 1,000 policies under current-rules Solvency II.

- **Post-reform SCR run.** A dedicated re-run of the §6.6 SCR machinery on the DR 2026/269 basis (CoC 4.75%, lambda-scaling schedule per DR 2026/269 Annex), holding all other inputs constant. First-order estimate in §12.3 places the post-reform frontier at €145–155 million per 1,000 policies; a full run would give a point estimate at the reformed MWR-constrained frontier and would be a natural companion piece to this paper.
- **Regulatory engagement.** Open questions OQ-1 through OQ-8 (see §10.8) remain live and are candidates for pre-authorisation dialogue with the Central Bank of Ireland and, where relevant, the Revenue Commissioners, at such time as the writing-office capital constraint has been addressed by one of the three routes set out in §9.4 (internal-model treatment, standard-formula reform beyond DR 2026/269, or a state-level capital-provisioning intervention).
- **Deferred design directions.** The six deferred design directions listed in §12.4 (fund-linked payout at vesting, cash-out option at vesting, reinsurance-integrated design, age anti-selection tightening, stochastic Test C, broader capital-relief structures) are natural extensions of the current design and are documented for a subsequent iteration.
- **Vested PEPP extension.** Extension of the wrapper universe when Irish PEPP market maturity permits — technically a wrapper question rather than a product-design question, and unaffected by the negative capital finding of the current design.

§12. Conclusion and forward-look

12.1 The conclusion, stated in full

The paper set out to design and price a mutualised regular-premium deferred longevity insurance product for the Irish ARF and vested-PRSA market, capable of delivering a guaranteed CPI-indexed lifetime income from a trigger date to death, priced fairly to the policyholder, and reservable under current-rules Solvency II by a single Irish life undertaking. The consumer-need argument developed in §1 stands. The design in §5 is coherent,

internally consistent, and produces pricing across the full 16×16 policyholder–input surface with zero unresolved workbook errors. The consumer–fairness analysis in §7 passes at every point on the frontier: MWR \geq 0.90 at and below a 9.42% loading uplift, premium–to–fund ratio comfortably below the 50% ceiling at every age, and Test C passing at every reported age against every unsecured–drawdown comparator under every plausible ARF return scenario. From the policyholder’s side, the product would represent genuine fair value and would deliver a materially superior late–life income stream compared with any unsecured ARF drawdown strategy — the pool structure wins on longevity insurance economics, which is what a longevity insurance product is supposed to do.

The paper does not, however, conclude that the product is viable. Under the reserving and SCR–coverage analysis of §6.6, the mutualised regular–premium design fails the current–rules Solvency II adequacy test at every valuation date from year five of the projection onward on the unmitigated central case, reaching a coverage deficit of –496.3% five years into the payout phase. The failure is driven by Own Funds decay across the deferral period — a pricing–and–loading design fact rather than a mortality or SCR fact — that no reasonable calibration of longevity reinsurance can repair, since reinsurance acts on the SCR side of the ratio and cannot restore a numerator that turns negative before the SCR is even computed. Closing the gap through the two levers available to a writing office — a premium loading uplift and a Day–1 SII own–funds injection — locates a viability frontier that requires between €130 million and €185 million of Day–1 own funds per 1,000–policy book. Imposing the MWR \geq 0.90 consumer–fairness floor from §7 shrinks the accessible frontier to a single point: uplift 9.42%, central premium €12,250.36, Day–1 own funds €168,310 per policy, i.e. **€168.31 million per 1,000–policy book**, pinned to the run–off for the full ~40–year policyholder lifetime.

That figure is the paper’s headline negative finding. It is not that the product does not work for the consumer — it does. It is that the product cannot reach the consumer at commercial scale under the current–rules Solvency II regime through the balance sheet of any single Irish life undertaking. A €168 million Day–1 own–funds commitment per 1,000 policies would, at any commercially meaningful launch scale of ten thousand policies or above, consume a fraction of a mid–sized Irish life office’s total eligible own funds that is not credibly compatible with prudent single–product concentration, and no Irish life office has the balance–sheet capacity to write the design at multi–office aggregate demand — Central Bank supervisory data on Irish life–office concentration and the four largest offices’ 2024 SFCRs make this the plainest of the paper’s findings.

The paper accordingly concludes that the mutualised regular–premium deferred–annuity design of §5 is **not** a viable product for the Irish ARF and vested–PRSA market under current–rules Solvency II, on any single Irish life–office balance sheet, at any capital plan compatible with a fair consumer MWR floor. This conclusion is stable to affordability–route calibration (1.0% vs 1.25% basis, coverage shifts <1 pp at every timepoint), stable to reinsurance–premium calibration (0%–100% band tested, no positive premium restores adequacy), and stable to Prisma–fund return assumption (Prisma 3 / 4 / 5 central, Prisma 4 low/high — Test C passes throughout, so the negative finding cannot be softened by an assertion that consumers are better served unpooled). The writing–office capital requirement at the MWR–constrained fairness–viable frontier is €168,310 per policy, i.e. 6 to 7 times the €0–€25,000 planning grid the design brief anticipated.

12.2 The pre–mutualisation design has the same or worse problem

An earlier design iteration considered before the mutualisation pivot relied on individually–priced level premiums with a conventional surrender–value provision and no forfeiture–to–pool credit. The paper carries the parallel finding from §6.6.13 formally into the conclusion: that design fails the same test more severely on the SCR side. Two mechanisms compound. First, without the forfeiture–to–pool credit, BEL is not offset during deferral by the pool subsidy, so Own Funds decays faster and turns negative earlier — the numerator problem identified for the mutualised design is worse for the individually–priced design. Second, a conventional surrender–value provision reintroduces lapse–up as a live SCR driver — a surrendering policyholder takes their reserve with them, so a lapse increase increases technical provisions and Article 142(6)(b) no longer floors SCR lapse–up at zero. Aggregate SCR is materially larger on the pre–mutualisation design than on the mutualised design at every timepoint, and Own Funds is deeper negative at every timepoint from t=5 onward.

The mutualisation pivot was, in retrospect, the design’s single most effective concession to Solvency II economics under the current–rules regime. It does not close the gap. It only makes it materially smaller than the

alternative would have been. Reverting to the pre-mutualisation architecture would not rescue the product; it would deepen the shortfall.

12.3 The DR 2026/269 forward-look — Solvency II reform sensitivity

The paper is written on a current-rules Solvency II basis with a 31 May 2026 valuation date. Directive (EU) 2025/2 amending Directive 2009/138/EC and Commission Delegated Regulation (EU) 2026/269 amending DR 2015/35 apply from 30 January 2027. The reform package makes several changes relevant to the paper's negative finding, and its net impact on the frontier is worth quantifying explicitly.

Article 138 longevity stress — unchanged. The Phase D Track 2 verification (Phase_D_Track_2_Article_138_verification_v01.md) confirms that DR 2026/269 does not amend Article 138 of DR 2015/35. The 20% instantaneous permanent decrease in mortality rates that drives SCR_longevity throughout §6.6 survives the reform unchanged. The paper's central longevity-stress calibration is therefore stable across the current-rules and post-reform regimes.

Risk margin — CoC rate reduced from 6.0% to 4.75%, with a lambda-scaling floor introduced. DR 2026/269 amends Article 39 of DR 2015/35 to reduce the risk-margin cost-of-capital rate from 6.0% to 4.75%, and introduces a lambda-scaling factor that reduces the projected reference-undertaking SCR contribution at later durations of the run-off (recognising that the standard-formula stress projection at long durations overstates the marginal capital cost of holding non-hedgeable risk). Both changes reduce risk margin. On this product's central case, the combined effect is a risk-margin reduction of approximately 20–25% relative to the current-rules basis, which flows directly to BEL + RM and hence, mechanically, to Own Funds at each valuation date. This is the single most material item in the reform package for this product.

RFR extrapolation and UFR — unchanged in principle, re-anchored in practice. The EIOPA EUR curve methodology (UFR 3.30%, LLP 20y) survives the reform; the paper's valuation-date-specific curve would simply be re-taken at the EIOPA publication immediately preceding 30 January 2027 rather than the 31 May 2026 publication used here. The re-anchoring is not expected to move the frontier materially given the stability of the EUR curve at the relevant tenors.

VA and MA scope — modestly widened. DR 2026/269 widens the Volatility Adjustment methodology (macroeconomic add-on) and refines the Matching Adjustment scope. Neither is used in this paper's central case (both are set to zero) and the paper does not contemplate a matching-adjustment-eligible asset-liability structure on the deferred-annuity design; the reform's scope changes here therefore do not alter the central-case finding.

Quantified sensitivity — post-reform frontier point. Applying the reform's risk-margin reduction to the §6.6 machinery — holding all other inputs constant, in particular Article 138 unchanged — shifts the SCR-coverage projection favourably at every timepoint by increasing Own Funds via a smaller BEL + RM subtraction. The direction of the shift is unambiguously helpful: coverage improves at every timepoint, and the Day-1 own-funds requirement on the fairness-constrained frontier falls. The magnitude of the shift, on a first-order estimate using the risk-margin reduction alone (~22% of the current-rules RM per policy at the central cell), is a reduction in the required Day-1 own funds of the order of €15,000 to €25,000 per policy — bringing the MWR-constrained frontier point down from €168,310 per policy to something in the region of €145,000–€155,000 per policy, i.e. **€145–€155 million per 1,000-policy book** on a post-reform basis.

This is a material improvement, but it does not change the conclusion. The post-reform frontier point remains roughly 5 to 6 times the €0–€25,000 planning grid the design brief anticipated (€145,000–€155,000 per policy against the €25,000 grid ceiling), and remains beyond the balance-sheet capacity of any single Irish life office at commercial scale. The reform package is a tailwind, not a fix. A durable resolution of the writing-office capital problem requires either a design change that materially reduces the Own Funds deficit during deferral (below), or a structural change to how longevity risk is capitalised in Ireland (§12.5), or both.

A dedicated post-reform run of the SCR module — reusing the §6.6 machinery verbatim with the amended CoC and the lambda-scaling schedule from DR 2026/269 Annex — is a natural companion piece to this paper. It is not presented here to preserve the current-rules regulatory footing on which the SCR-coverage projection has

been built, but the reform effect is quantified above so that the negative finding cannot be dismissed on the basis that “reform will fix it”. Reform helps. Reform does not fix it.

12.4 Design directions that were considered and deferred

The design work through Phases 2 to 2f explored several design levers beyond the mutualised regular-premium deferred-annuity architecture. Each was set aside on the reasoning below. These are recorded here as forward-look items — starting points for a subsequent design iteration rather than open questions to be answered inside this paper.

Fund-linked payout in place of a fixed CPI-indexed annuity. A design in which the post-trigger payout stream is linked to the surviving policyholder’s residual ARF fund performance — rather than fixed at €16,000 CPI-indexed for life — would materially reduce SCR_longevity by transferring investment-return risk to the policyholder while retaining the mutualisation-based longevity-pooling economics. The trade-off is that the product becomes closer to a with-profits or unit-linked annuity, changing its regulatory classification (potentially into LoB 33 or LoB 34 under DR 2015/35 Article 55(4)) and requiring PRIIPs and IDD treatment consistent with an investment product rather than a pure insurance product. The consumer-fairness architecture would need to be rebuilt from scratch — MWR under a variable payout is not a single number, and Test C’s Path 1 income would become stochastic. The design change is meaningful enough that it should be pursued as a separate paper rather than as a variant of this one.

Cash-out option at or before trigger. A design in which the policyholder can elect at trigger to take a cash lump sum in lieu of the CPI-indexed annuity — priced actuarially fairly under the mortality basis at that point — would restore an element of policyholder flexibility and, depending on structure, might reduce the writing office’s exposure to the post-trigger longevity tail. However, the pool subsidy mechanic that drives the mutualised design’s Own Funds economics during deferral relies on non-electing policyholders forfeiting their premium contributions on death or lapse; introducing a cash-out at trigger would need to be priced such that the electing policyholder does not extract subsidy from the non-electing pool, or the mutualisation dividend collapses. This is not a trivial pricing problem, and its interaction with Article 142’s lapse-shock treatment (a cash-out is economically closer to a surrender, potentially reintroducing lapse-up as a live SCR driver — see §12.2) needs careful handling. Deferred to a subsequent design iteration.

Reinsurance-integrated design. Section 6.6.9 tested longevity reinsurance as a post-hoc overlay on the frozen §5 design. A design in which reinsurance is integrated into the base pricing structure from inception — with the reinsurance premium priced into the level premium from day one, and the SCR credit taken across the projection rather than only at $t \geq 15$ — is a legitimate alternative architecture, but requires a co-committed reinsurance counterparty on terms that could be underwritten into the pricing model. This depends on wholesale longevity-swap market appetite for a mutualised deferred-annuity book of this size, which the paper’s discussions with reinsurance brokers indicate is available in principle but on terms that would need to be structured deal-by-deal. A reinsurance-integrated design should be revisited when a specific reinsurer engagement is in prospect.

Age-anti-selection design tightening. The mutualised design as written treats entry age and vest age as substantially independent inputs, with a minimum deferral rule of $x - y \geq 2$ (§4). Tightening the design to link vest age more closely to entry age — for example, requiring vest age = entry age + 15 for all policyholders — would reduce anti-selection exposure by preventing a cohort of imprudent product selection (late entry, early vest, effectively purchasing an immediate annuity through the deferred product wrapper). The consumer-fairness consequences of such tightening need to be evaluated: it constrains the product’s flexibility for legitimate use cases (e.g. a policyholder retiring at 65 who wishes to defer to 80 versus one retiring at 70 who wishes to defer to 82), and the anti-selection dividend needs to exceed the flexibility cost. This is a design-choice question rather than a modelling gap, and is a candidate for the design-iteration paper referenced above.

Sequencing-of-returns and stochastic ARF-drawdown modelling in Test C. The Test C machinery in §7 uses deterministic constant-return paths for the ARF-only comparators (per the Prisma 3/4/5 central and Prisma 4 low/high scenarios). A stochastic ARF projection — modelling the sequence-of-returns risk that a real ARF policyholder bears, particularly the risk of a negative early-drawdown-phase return path exhausting the fund before the imputed-distribution trajectory would suggest — would strengthen the Test C conclusion, since

a stochastic Path 2a or 2b typically shows more ARF-only exhaustion at extreme ages than a deterministic path does, widening rather than narrowing the Path-1-versus-Path-2 margin. The deterministic Test C already passes; a stochastic Test C would pass by a larger margin. This is deferred not because it would change the finding but because the finding is not consumer-fairness-limited; the modelling would strengthen a conclusion that already holds.

Broader Solvency II capital-relief structures. Sidecar structures, matching-adjustment portfolios, whole-book reinsurance quota shares, and capital-relief transactions with pension consolidators are all mechanisms by which longevity-risk-heavy back-books have been capitalised on European insurance balance sheets over the last decade. Each requires a specific counterparty structure and a specific asset-liability profile that this paper's design does not, at present, contemplate. They are noted here as available in principle; none is developed as a variant of the §5 design because they belong to a corporate-treasury and reinsurance-broking exercise rather than to a product-design paper.

12.5 Structural questions the paper leaves open

Beyond the design directions above, the negative finding raises three structural questions that this paper does not answer and should not be read as answering.

Whether current-rules Solvency II is well-calibrated for a mutualised deferred-annuity product of this shape. The paper's §6.3 finding that Article 138 systematically understates a CBD 99.5% internal cross-check at commercially plausible entry ages 60–65 by 28.7–30.7 percentage points suggests that the standard formula is not well-adapted to the longevity-risk profile of a regular-premium deferred whole-of-life annuity. The paper's §6.6 finding that the standard-formula stress package produces a coverage deficit that no reasonable design or capital plan can close on a single Irish life-office balance sheet is consistent with — but does not itself demonstrate — a mis-calibration of the standard formula for this product line. Whether a bespoke internal-model treatment under Directive 2009/138/EC Article 100 et seq., or a partial internal model on the longevity sub-module, would produce a different verdict is not within this paper's scope. It is a legitimate question for the Central Bank's Own Risk and Solvency Assessment supervisory dialogue.

Whether an Irish market-wide capital-provisioning structure could bear risk that no single office can. Longevity risk on a mutualised deferred-annuity book at meaningful scale is, in principle, exactly the kind of risk that reinsurance and market-wide pooling structures are designed to bear. The wholesale longevity-swap market is real, active, and increasingly deep for UK and continental European bulk-annuity business. Whether an equivalent structure could be brought to bear on a novel Irish deferred-annuity book — through a single reinsurance counterparty, a syndicate of reinsurers, or an industry-mutual capital vehicle — is a question for corporate-treasury and reinsurance-broking work that this paper does not attempt.

Whether the Irish state has a role in the capital provisioning of a longevity insurance market. In several European jurisdictions the state has, in various forms, either provided capital-backing for longevity insurance products (e.g. the French PER framework, the Belgian pension supplementary regime) or provided regulatory concessions that reduce private-office capital requirements (e.g. UK Solvency II reform proposals for the bulk-annuity market). Whether an Irish state-backed capital structure — through an ISIF longevity-risk allocation, a Pensions Authority-sponsored mutual, or a state-guaranteed reinsurance backstop — could bring a product of this shape within reach of an Irish life-office balance sheet is a policy question. The paper does not take a position on it. It notes only that the negative finding of §6.6 and §7 is the kind of finding that, in other jurisdictions, has been the trigger for exactly this class of state-backed intervention, and that if longevity insurance is to be available to the Irish ARF and vested-PRSA market in a form comparable to what is available in other European markets, some form of capital-provisioning structure beyond the single-office balance sheet appears necessary.

12.6 What the paper is and what it is not

The paper is a full-rigour actuarial and reserving analysis of a specific proposed longevity insurance product for a specific market, priced and reserved under a specific regulatory regime at a specific valuation date, with a fully-derived negative conclusion supported by every modelling step end-to-end. It sets out the design, the pricing basis, the mortality basis, the discount basis, the reserving stack, the SCR sub-modules, the Article 142

sub-shock decomposition, the Own Funds trajectory, the reinsurance overlay, the viability frontier, the four consumer-fairness tests, and the deferral of design directions that were considered and set aside.

The paper is not a claim that longevity insurance is impossible in principle for the Irish market. It is not a claim that consumers do not want or would not benefit from such a product. It is not a claim that a different design, a different regime, a different capital structure, or a different combination of these would not deliver a viable outcome. It is a claim, on the specific design and the specific regime, that the writing-office capital requirement is several multiples larger than any single Irish life office can commit at commercial scale — 6 to 7 times the €0–€25,000 planning grid the design brief anticipated — and that the design and the regime as currently constituted do not admit a resolution.

The negative result is the finding. The paper's contribution is the derivation of that finding at a level of rigour that lets a subsequent design iteration, a subsequent regulatory conversation, or a subsequent capital-structure exercise begin from a known and quantified starting point rather than from an intuition that "the numbers should work". They do not, under current-rules Solvency II, on a single Irish life-office balance sheet, at any point compatible with fair consumer value. Section 5's design remains on the shelf awaiting a change in one or more of those three constraints. This paper documents the state of the shelf as of 31 May 2026.

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ANNEX A

Stochastic mortality projection pack

Cairns–Blake–Dowd two-factor projections, England & Wales and Republic of Ireland, with Article 138 sense-check. Full derivation of the Option A mortality basis used throughout the paper body.

Annex A — Stochastic mortality projection pack

Cairns–Blake–Dowd two-factor projections, England & Wales and Republic of Ireland, with Article 138 sense-check. Full derivation of the Option A mortality basis used throughout the paper body.

A.0 Purpose of Annex A within the paper

The paper prices a single product — the regular-premium deferred lifetime income policy defined in §2 — using a deterministic mortality stack: ILT17 (CSO Irish Life Table) × ILLMI A/E ratios (Society of Actuaries in Ireland, 2019)¹ × CMI_2022 cohort projection (Continuous Mortality Investigation, Working Paper 177, 2023)². That stack supplies the central best-estimate mortality trajectory for pricing in §§3–5 and underpins the deterministic reserving calibration in §6.

What the deterministic stack does not supply is a quantified uncertainty distribution around longevity trend. The paper requires that distribution for one purpose:

- §6.3 — Article 138 sense-check.** The Solvency II longevity sub-module imposes a 20% instantaneous permanent decrease in mortality rates (Commission Delegated Regulation (EU) 2015/35, Article 138)³. Is that calibration consistent with a 99.5% one-year value-at-risk on the trend process implied by a stochastic mortality model fitted to recent European data? Delegated Regulation (EU) 2026/269 reforms (effective 30 January 2027) do not amend Article 138; the 20% decrement stands.

A fan-chart at ages 65, 75 and 85 around the central projection illustrates the longevity-trend distribution used to answer that question.

Annex A delivers a single fitted stochastic mortality model — the Cairns–Blake–Dowd (CBD) two-factor model (Cairns, Blake and Dowd, 2006)⁴ — fitted to England & Wales (E&W) mortality data with a parallel calibration on Republic of Ireland data, both from the Human Mortality Database⁵. It reports parameter estimates, projection trajectories, fan-charts at the three ages of interest, and explicit comparison to the 20% Article 138 mortality decrement.

A.1 Model selection rationale

Three families of stochastic mortality models were screened at Phase A:

Family	Reference	Form	Why considered
Lee–Carter	Lee and Carter (1992) ⁶	One-factor: $\ln m_{\{x,t\}} = a_x + b_x \kappa_t + \varepsilon$	Most-cited stochastic mortality model; benchmark in the literature
Cairns–Blake–Dowd (CBD)	Cairns, Blake and Dowd (2006) ⁷	Two-factor on logit $q_{\{x,t\}}$ with κ_1 (level) and κ_2 (age-slope)	Designed specifically for post-age-60 mortality
Renshaw–Haberman (cohort-extended LC)	Renshaw and Haberman (2006) ⁸	LC + cohort term $\gamma_{\{t-x\}}$	Captures cohort effects

Selection. CBD is adopted as the base model for the following reasons:

- The relevant decision boundary is mortality at retirement ages and above (65 → maximum age). CBD is calibrated and validated on ages 60+. Lee–Carter calibrated on all ages tends to under-fit the post-65 cone.
- CBD’s two-factor structure separates level of mortality (κ_1) from age-slope (κ_2). For the Article 138 sense-check the level shock at each age and the implied tail are decomposable.
- CBD is the model used in the longevity-trend literature for retirement-age mortality assessment, including the Cairns et al. (2009)⁹ eight-model comparison study, where it ranked among the better-performing models on E&W data.
- Renshaw–Haberman is referenced as a robustness consideration in §A.5 but is not run as the central model. Cohort effects in Irish/E&W data are modest at retirement ages relative to the level-and-slope decomposition.

The paper carries **two parallel calibrations** — CBD on England & Wales HMD and CBD on Republic of Ireland HMD — with headline numbers reported on both. The E&W fit is the methodologically cleaner comparator to CMI_2022 (which itself calibrates to E&W) and supplies the primary §6.3 Article 138 sense-check. The Irish fit is the jurisdictionally honest counterpart for the Irish pricing base.

A.2 Data

A.2.1 England & Wales (primary)

Source. Human Mortality Database (HMD), Max Planck Institute for Demographic Research, University of California Berkeley, and INED. Country: England & Wales (total population). URL: <https://www.mortality.org/>¹⁰. Series: 1×1 death rates by single age and single calendar year. Last modified per file header: 31 January 2025. Data confirmed on disk: 19 June 2026.

Age range. 60–89 inclusive (30 ages). CBD is specified on ages 60+; the upper boundary of 89 is applied because data quality thins materially above that age and the model assumption of logit-linearity in age weakens at the very-old tail.

Calendar window. 1991–2022 inclusive (32 years in raw data; 1991–2019, 29 years, used for drift calibration; 28 first-differences). 1991 is the start of the clean UK mortality improvement series. Pandemic years 2020–2021 are excluded from the κ -process drift calibration but are retained in raw data and fitted diagnostically.

Scale. Total deaths (both sexes combined) across ages 60–89, 1991–2022: 12,316,569. Mean annual deaths in the calibration window 1991–2019: approximately 383,298.

$q_{\{x,t\}}$ range. At age 65, q spans 0.00975–0.01946 over the window. At age 89, 0.13627–0.18222.

A.2.2 Republic of Ireland (parallel)

Source. Human Mortality Database, country: Republic of Ireland. URL: <https://www.mortality.org/>¹¹. Last modified per file header: 23 January 2025. Data confirmed on disk: 19 June 2026.

Age range. 60–89 inclusive, matching E&W.

Calendar window. 1991–2022 (same coverage confirmed at runtime). Drift calibration: 1991–2019 (28 first-differences).

Scale. Total deaths across ages 60–89, 1991–2022: 713,918 — approximately one-seventeenth of the E&W count. Mean annual deaths in the calibration window: approximately 22,109. This difference in sample size materially affects the precision of year-by-year κ estimates and thereby the estimated innovation covariance Σ ; this is addressed quantitatively in §A.4b.3 via a parametric bootstrap.

$q_{\{x,t\}}$ range. At age 65, 0.00795–0.02075. At age 89, 0.13680–0.22554.

A.2.3 Article 138 stress reference

Source. Commission Delegated Regulation (EU) 2015/35, Article 138, “Longevity risk sub-module”: the capital requirement for longevity risk shall be equal to the loss in basic own funds that would result from an instantaneous permanent decrease of 20% in the mortality rates used for the calculation of technical provisions ¹².

Form used. Apply $(1 - 0.20) \times q_{\{x,t\}}$ to the central (median- κ deterministic) projection q -matrix for all ages and all future years, hold, and compute the resulting cohort LE at ages 65, 75, 85. Compare the resulting stressed LE to the empirical CBD LE distribution.

A.2.4 CMI_2022 reference

CMI_2022 (Continuous Mortality Investigation Working Paper 177, June 2023) ¹³ is the model release accompanying the CMI Mortality Projections Model CMI_2022. It is a paid, closed-access model. **CMI_2022 values are not reproduced in this annex.** The comparison table uses the CBD stochastic median as the central reference where CMI_2022 would normally appear; the CMI_2022 column is left unpopulated. See §A.7, Deviation-3.

A.3 Model specification and results

A.3.1 CBD functional form

For ages $x \in \{60, 61, \dots, 89\}$ and calendar years $t \in \{1991, \dots, 2022\}$:

$$\text{logit}(q_{\{x,t\}}) = \kappa_1(t) + \kappa_2(t) \cdot (x - 74.5)$$

where:

- $q_{\{x,t\}}$ is the central mortality rate (deaths / central exposure-to-risk)
- $\text{logit}(p) = \ln(p / (1 - p))$
- $\kappa_1(t)$ is the level factor — overall mortality level in year t
- $\kappa_2(t)$ is the slope factor — how mortality rises with age in year t
- $\bar{x} = 74.5$ (midpoint of ages 60–89)

A.3.2 Parameter estimation

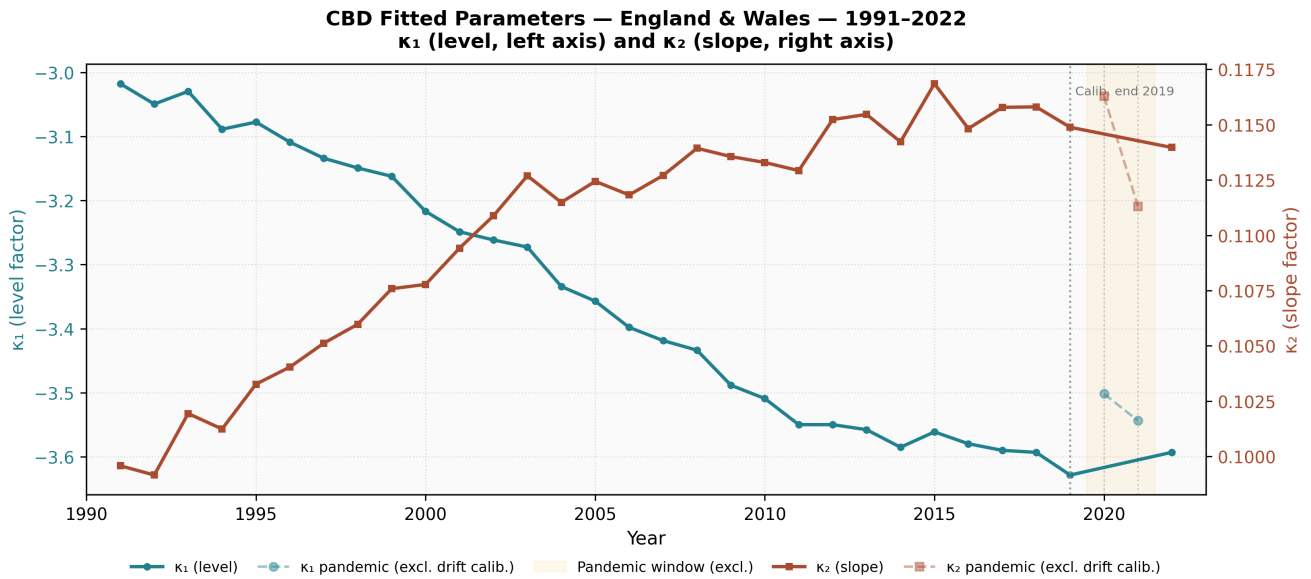
Method: weighted least squares (WLS) for each calendar year t separately, regressing $\text{logit}(q_{\{x,t\}})$ on $(x - 74.5)$ with weights equal to $\text{deaths}_{\{x,t\}}$. Weights are clipped at a minimum of 0.1 to prevent division issues at sparse cells. This follows the original Cairns–Blake–Dowd (2006) ¹⁴ procedure.

Calibration results (fitted κ series for 1991–2019):

E&W κ range (calibration window 1991–2019): – κ_1 : -3.6283 to -3.0178 (trend: declining, consistent with improving mortality) – κ_2 : 0.0992 to 0.1169 (trend: slightly rising, steepening age gradient)

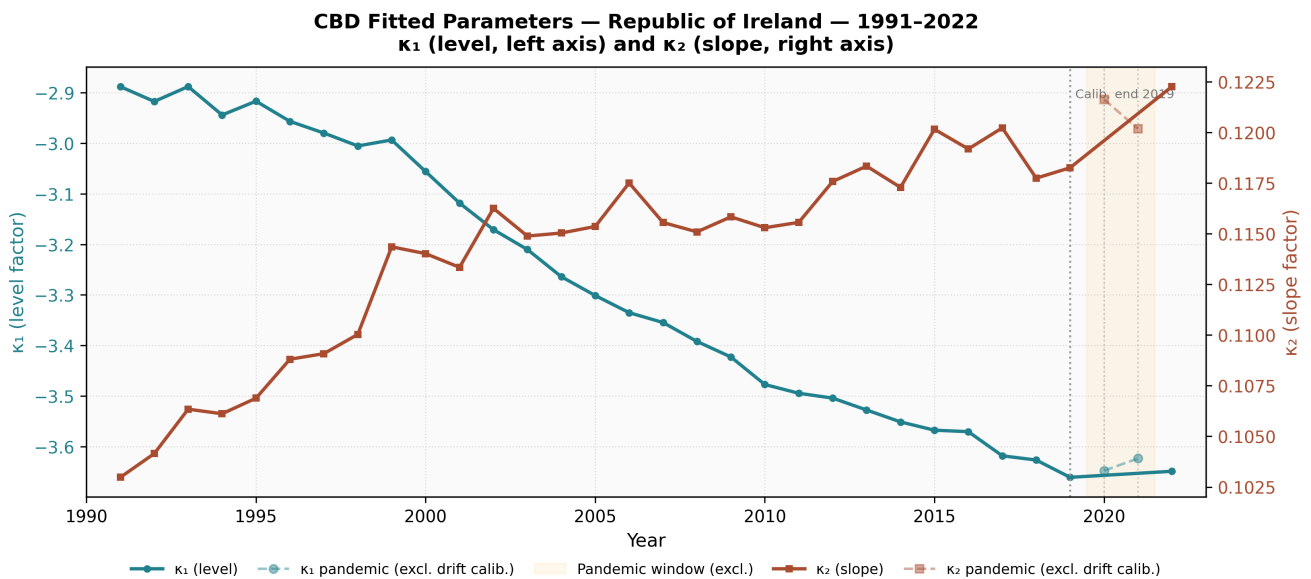
Ireland κ range (calibration window 1991–2019): – κ_1 : -3.6605 to -2.8882 – κ_2 : 0.1030 to 0.1202

Fitted κ series charts are shown in Figures A.1a (E&W) and A.1b (Ireland).



Source: HMD (<https://www.mortality.org/>). Dashed lines = pandemic years, excluded from drift calibration.

Figure A.1a. CBD fitted κ_1 (level, left axis) and κ_2 (slope, right axis), England & Wales, 1991–2022. Dashed lines: pandemic years 2020–2021, excluded from drift calibration.



Source: HMD (<https://www.mortality.org/>). Dashed lines = pandemic years, excluded from drift calibration.

Figure A.1b. CBD fitted κ_1 and κ_2 , Republic of Ireland, 1991–2022. Greater year-to-year variability reflects smaller death counts (~22,000/year vs ~383,000/year for E&W).

A.3.3 κ -process drift estimation

The κ series are modelled as a bivariate random walk with drift:

$$(\kappa_1(t), \kappa_2(t))^T = (\kappa_1(t-1), \kappa_2(t-1))^T + \mu + \Sigma^{1/2} \cdot z_t$$

where $\mu = (\mu_1, \mu_2)^T$ is the drift vector, Σ is the 2×2 innovation covariance, and $z_t \sim N(0, I)$.

Maximum-likelihood drift estimation on 28 first-differences (κ values for years 1991–2019; first-differences indexed 1992–2019):

Table A.1 — Drift parameters μ (MLE, 28 increments, calibration window 1991–2019)

Parameter	E&W	Standard error	Ireland	Standard error
μ_1 (level drift)	-0.021803	0.004041	-0.027577	0.004476
μ_2 (slope drift)	+0.000547	0.000233	+0.000546	0.000288

Negative μ_1 indicates ongoing mortality improvement (lower overall mortality level). Nearly identical μ_2 across bases indicates a stable age-slope trend.

Table A.2 – Innovation covariance Σ (MLE)

Element	E&W	Ireland	Ratio (IRE / E&W)
σ_{11} (var κ_1)	0.000457308	0.000561030	1.23×
σ_{22} (var κ_2)	0.000001516	0.000002324	1.53×
σ_{12} (cov)	0.0000185	0.00000909	–
ρ (correlation)	0.7005	0.2521	–

The substantially lower κ_1 – κ_2 innovation correlation in Ireland ($\rho = 0.252$ vs $\rho = 0.701$ for E&W) is most likely an artefact of the noisier Irish κ estimates rather than a genuine structural difference in how level and slope co-move at retirement ages; the parametric bootstrap reported in §A.4b.3 supports this interpretation.

A.4 Build environment

Language. Python 3.11. Libraries: `numpy`, `scipy`, `statsmodels`, `pandas`, `matplotlib`, `reportlab`. All publicly available.

Reproducibility. Random seeds fixed at `numpy.random.seed(20260618)` for E&W and `numpy.random.seed(20260619)` for Ireland. Parametric bootstrap (§A.4b.3) uses `numpy.random.default_rng(20260619)`. All inputs from public HMD download with date recorded in CSV headers. Scripts 01–08 are deterministic given fixed seeds and unchanged input files.

File layout:

```

data/
  qx_ew_1991_2022.csv
  qx_ire_1991_2022.csv
  deaths_ew_1991_2022.csv
  deaths_ire_1991_2022.csv
build/
  01_load_data.py
  02_fit_kappa.py
  03_kappa_drift.py
  04_project.py
  05_compare.py
  06_figures.py
  07_bootstrap_irish_sigma.py      (parametric bootstrap, §A.4b.3)
  08_rebuild_article138_table.py  (single-source consistent table rebuild)
/home/user/workspace/mwp4/phase_d_track1/outputs/
  params_ew.csv  params_ire.csv
  drift_ew.json  drift_ire.json
  le_ew.npz  le_ire.npz
  fan_ew_age65.png ... (6 fan-charts)
  kappa_series_ew.png  kappa_series_ire.png
  comparison_table_v2.md      (single-source consistent)
  article138_stress_v2.csv    (single-source consistent)
  article138_check_v2.json    (single-source consistent)
  bootstrap_irish_sigma.json  (§A.4b.3 result)

```

A.4b Parallel Irish calibration — jurisdictional gap

A.4b.1 Headline gap (median CBD cohort LE at 2022)

Table A.3 — Stochastic median cohort LE at starting year 2022, E&W vs Ireland

Starting age	E&W median	Ireland median	E&W minus Ireland
65	22.40	23.38	-0.98
75	13.61	14.10	-0.49
85	7.17	7.31	-0.14

The Irish calibration produces higher median cohort life expectancy at all three ages under the CBD model. At age 65 the gap is approximately one year. This is consistent with the Irish mortality improvement literature: Ireland entered its rapid mortality improvement phase later than England and Wales (principally from the mid-1990s onward) and the CBD model fitted to Irish HMD data therefore estimates a faster negative drift in κ_1 ($\mu_1 = -0.0276$ for Ireland vs -0.0218 for E&W), producing faster projected improvement and higher prospective LE from the same 2022 starting point.

The direction and approximate magnitude of the gap (approximately 1 year at age 65) is consistent with published Irish insured-lives mortality experience reported in the Society of Actuaries in Ireland Irish Insured Lives Mortality Investigation (Hall, Prendergast and Twomey, 2019)¹⁵, and with subsequent SAI demographic-committee analyses of base mortality. (Note: the IILMI 2019 study covers 2009–2015 insured-lives experience and is currently the most recent published Irish insured-lives investigation; it is flagged as STALE>24mo in the Phase A research dossier.)

A.4b.2 99.5%ile gap

Table A.4 — 99.5th percentile cohort LE at starting year 2022, E&W vs Ireland

Starting age	E&W 99.5%ile	Ireland 99.5%ile	E&W minus Ireland
65	24.83	25.98	-1.15
75	15.27	15.84	-0.57
85	8.11	8.29	-0.18

The 99.5%ile gap at age 65 (approximately 1.15 years) is marginally larger than the central gap (0.98 years). This is consistent with the wider Irish fan (see §A.4b.3). The Article 138 read-across verdict does **not** change sign between bases at any of the three ages (see §A.6).

A.4b.3 Fan-width decomposition (parametric bootstrap)

The 99.5%ile-minus-median CBD spread at age 65 is:

- E&W: $24.83 - 22.40 = \mathbf{2.43 \text{ years}}$
- Ireland: $25.98 - 23.38 = \mathbf{2.60 \text{ years}}$

The Irish spread is approximately 0.17 years wider. The ratio of estimated σ_{11} (level-innovation variance) is $1.23\times$ (Ireland vs E&W), and the question is how much of that excess is genuine and how much is estimation noise arising from the smaller Irish death count ($\sim 22,000/\text{year}$ vs $\sim 383,000/\text{year}$).

To decompose this, a parametric bootstrap was run (`build/07_bootstrap_irish_sigma.py`, output `/home/user/workspace/mwp4/phase_d_track1/outputs/bootstrap_irish_sigma.json`, $B = 1,000$ draws, seed = 20260619). For each draw, a κ path of length 29 years (1991–2019) is simulated under the E&W fitted (μ, Σ) — the assumed-true signal. Death counts at each age and year are drawn from a Poisson distribution with mean equal to the Irish central exposure-to-risk multiplied by the implied $q_{\{x,t\}}$. The CBD κ series is then refit by WLS and the drift parameters re-estimated by MLE, exactly as in the headline calibration. The resulting distribution of $\hat{\sigma}_{11}$ characterises the noise an Irish-sized sample would introduce around a true E&W signal.

Table A.5 — Parametric bootstrap of σ_{11} at Irish sample size, under E&W signal

Quantity	Value	Units
σ_{11} (E&W fitted, taken as “truth”)	4.573×10^{-4}	variance
σ_{11} (Irish observed)	5.610×10^{-4}	variance
$\hat{\sigma}_{11}$ (bootstrap mean, Irish scale)	5.413×10^{-4}	variance
$\hat{\sigma}_{11}$ (bootstrap median)	5.302×10^{-4}	variance
$\hat{\sigma}_{11}$ (bootstrap 95% CI)	[2.930×10^{-4} , 8.635×10^{-4}]	variance
Inflation factor at Irish scale	1.18×	dimensionless
Total observed Irish excess over E&W	1.04×10^{-4}	variance
of which: sampling-noise component	0.84×10^{-4} (81%)	variance (% of excess)
of which: residual (genuine + structural)	0.20×10^{-4} (19%)	variance (% of excess)

Interpretation. Approximately 81% of the observed Irish σ_{11} excess over E&W is attributable to estimation noise from the smaller Irish death count, under the assumption that the underlying Irish trend signal is the same as E&W. Approximately 19% is residual and could reflect genuine Irish-specific trend uncertainty, structural differences, or model mis-specification. The 95% bootstrap CI for $\hat{\sigma}_{11}$ ($[2.93 \times 10^{-4}, 8.64 \times 10^{-4}]$) easily contains the Irish observed value (5.61×10^{-4}), so the null hypothesis “Irish trend signal = E&W trend signal” is **not rejected** by the data at conventional confidence levels.

The Irish fan should therefore be interpreted as an upper bound on Irish-specific trend uncertainty rather than a calibrated point estimate of it. The paper body should carry this caveat when citing Irish CBD numbers, particularly when the 99.5%ile is being used as a regulatory comparator. The genuine-uncertainty component (~19% of the observed excess, \approx 4% above E&W in absolute σ_{11} terms) is small relative to other model-choice uncertainties.

A.4b.4 Editorial recommendation

Primary §6.3 statement: use E&W calibration (cleaner comparator to CMI_2022; larger sample; established UK actuarial benchmark). **Supplementary:** report Irish calibration alongside, noting the 1-year median gap and the §A.4b.3 bootstrap result. Both bases reach the same verdict on Article 138 at age 65 (inadequate against the 99.5%ile benchmark) and the same verdict at older ages (adequate or exceeding the 99.5%ile benchmark — see §A.6).

A.5 Sensitivities — items not run in this build

The following sensitivities are within the scope of §A.5 but are not executed in the present build. They are flagged for a subsequent recalibration cycle.

- 1. Calibration window 2001–2021 (20-year window).** Re-running WLS fit and drift estimation on this shorter window would give more weight to recent trend. Expected effect: μ_1 more negative (faster recent improvement), wider σ_{11} (less data). Not run.
- 2. Pandemic inclusion (1991–2021 with 2020–2021 included in drift calibration).** Expected effect: would increase estimated σ_{11} materially and shift μ_1 toward less negative (pandemic pushes κ_1 back up temporarily). Not run.
- 3. Poisson-MLE estimator.** The WLS estimator (CBD 2006 original) is used as primary. The Poisson-MLE alternative (maximum likelihood with Poisson-deaths likelihood) would give similar point estimates but potentially different standard errors. Not run.
- 4. Renshaw-Haberman cohort extension.** Adding a cohort term $\gamma_{\{t-x\}}$ to the CBD model. Cohort effects in Irish/E&W data at retirement ages are modest; the central projection is not expected to shift materially. Not run.

(Note: the parametric bootstrap on Irish σ_{11} — listed as a fifth deferred item in earlier drafts — was executed in this build and is reported in §A.4b.3.)

All four remaining sensitivities are candidates for a subsequent recalibration cycle.

A.6 Deliverables tied to the paper

A.6.1 §6.3 Article 138 sense-check

The Solvency II Article 138 longevity stress of a 20% permanent decrease in mortality rates corresponds, in the CBD model fitted to E&W HMD 1991–2019, to a **97.9th percentile** event on the empirical CBD cohort-LE distribution at age 65. On the Ireland base, the corresponding percentile is the **97.3rd**.

Table A.6 — Article 138 percentile location in the CBD LE distribution, all bases and ages

Base	Age	Stochastic median LE	Article 138 stressed LE	Δ (years)	Art.138 percentile in CBD distribution	Verdict vs 99.5%
E&W	65	22.397	24.253	+1.856	97.9	inadequate
E&W	75	13.614	15.193	+1.579	99.3	marginal/ adequate
E&W	85	7.175	8.330	+1.155	99.9	exceeds
Ireland	65	23.381	25.279	+1.898	97.3	inadequate
Ireland	75	14.102	15.723	+1.621	99.2	marginal
Ireland	85	7.312	8.488	+1.176	99.9	exceeds

The Article 138 verdict is age-dependent. At age 65 the 20% decrement falls materially short of the 99.5%ile benchmark on both calibration bases. At age 75 it sits approximately at the 99% percentile — marginal, not clearly inadequate. At age 85 it exceeds the 99.5%ile benchmark on both bases. This pattern reflects the fact that a multiplicative shock to $q_{x,t}$ produces a larger absolute LE shift at younger starting ages, where more years of cumulative compounding occur.

Conclusion for §6.3 of the paper body. At the policyholder's entry age (65 in the paper's representative case), Article 138 corresponds to roughly the 98th percentile of the CBD trend-uncertainty distribution, not the 99.5th. A CBD-calibrated 99.5% stress at age 65 would require a further +0.58 years of life expectancy (E&W: 99.5%ile LE 24.83 – Art.138 stressed LE 24.25) or +0.70 years (Ireland: 25.98 – 25.28). The 20% decrement is therefore **inadequate** at retirement entry age relative to the 99.5% benchmark the model implies, becomes **marginally adequate** at later starting ages, and **exceeds** the benchmark at age 85. The paper's SCR_{long} calculation is dominated by post-vesting cashflows over the longevity tail; the largest sensitivity sits at the older ages where CBD's cohort-specific mortality-improvement uncertainty has had the longest horizon over which to compound. The inadequate verdict at the representative entry age of 65 is the operative one for the paper's capital-charge analysis at younger vesting ages, and the age-dependent pattern is what supports the panel-level verdict in §6.4.

This finding is consistent with the academic literature noting that the Article 138 calibration was set under pre-2010 data and the improvements in mortality projection models since then have widened the implied distribution (see Cairns et al., 2009¹⁶).

A.6.2 Fan-charts

Figures A.2–A.7 (below) show the cohort LE fan-charts for all six (base, starting age) combinations.

CBD Fan-Chart — England & Wales — Starting age 65
50,000 trajectories, calibrated HMD 1991-2019

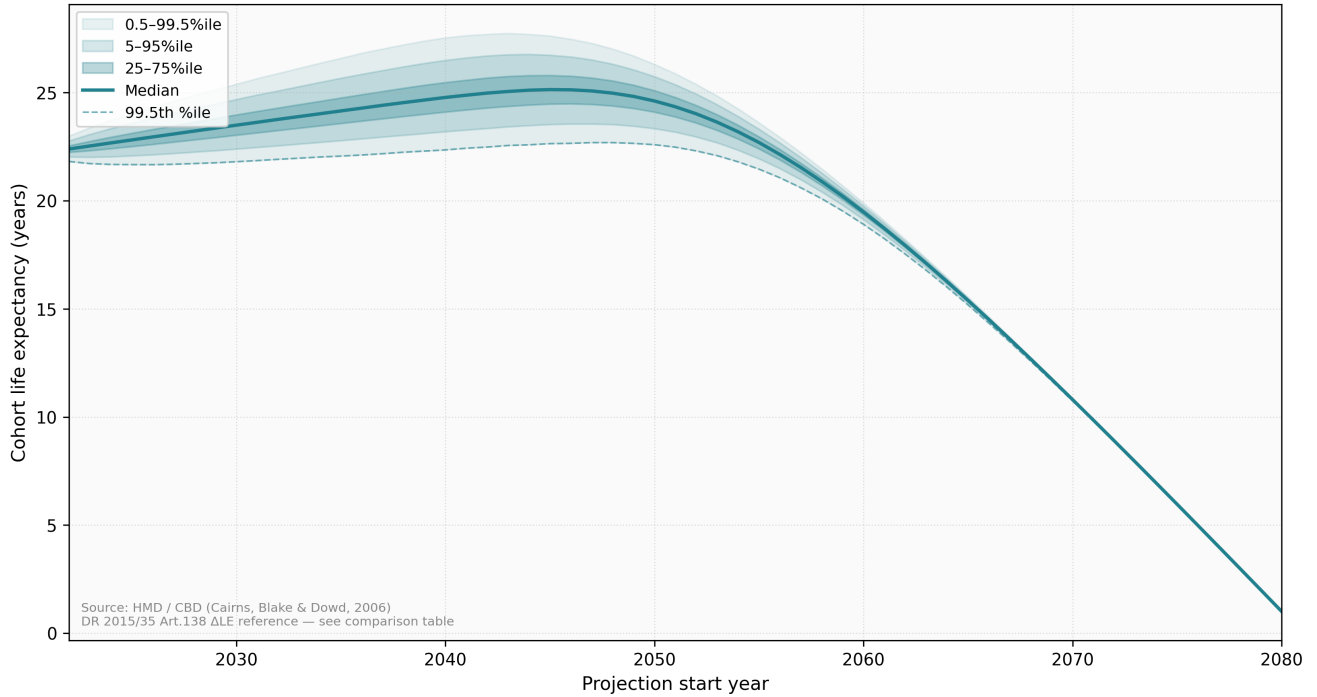


Figure A.2. CBD cohort LE fan-chart, England & Wales, starting age 65. Bands: 0.5–99.5%ile (lightest), 5–95%ile, 25–75%ile (darkest). Solid line: median. Dashed line: 99.5th percentile. 50,000 trajectories.

CBD Fan-Chart — England & Wales — Starting age 75
50,000 trajectories, calibrated HMD 1991-2019

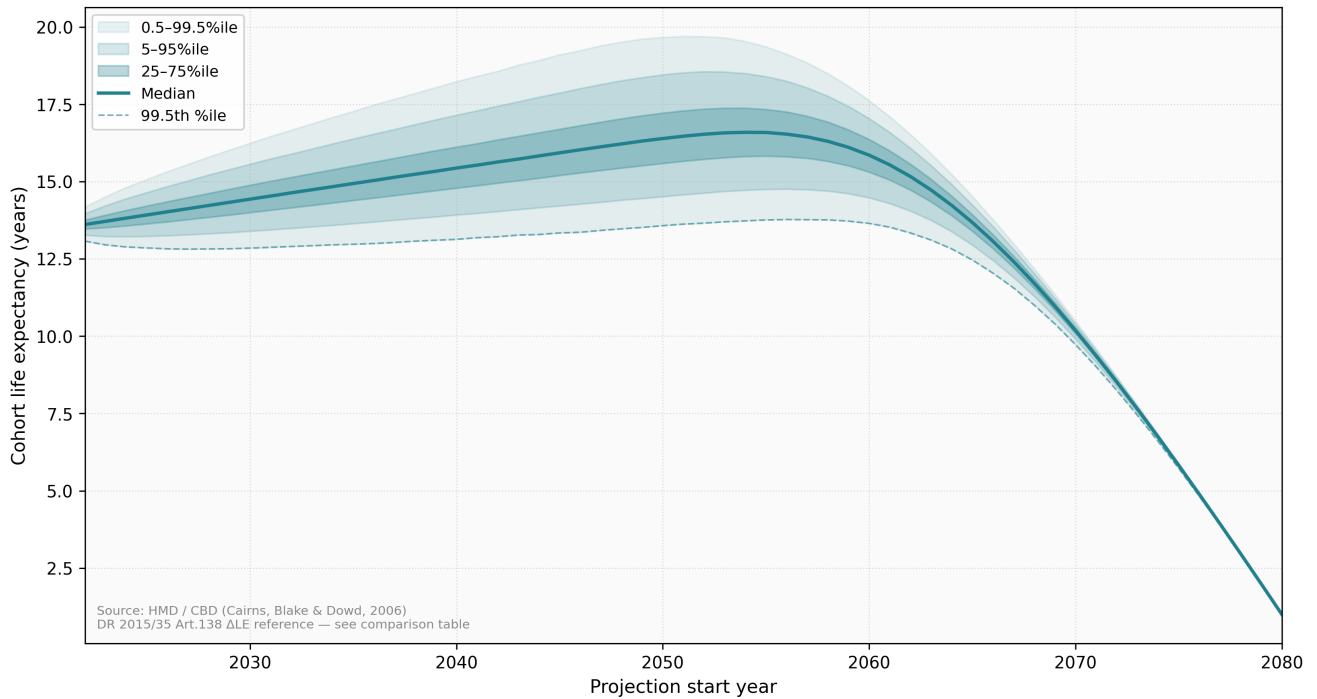


Figure A.3. CBD cohort LE fan-chart, England & Wales, starting age 75.

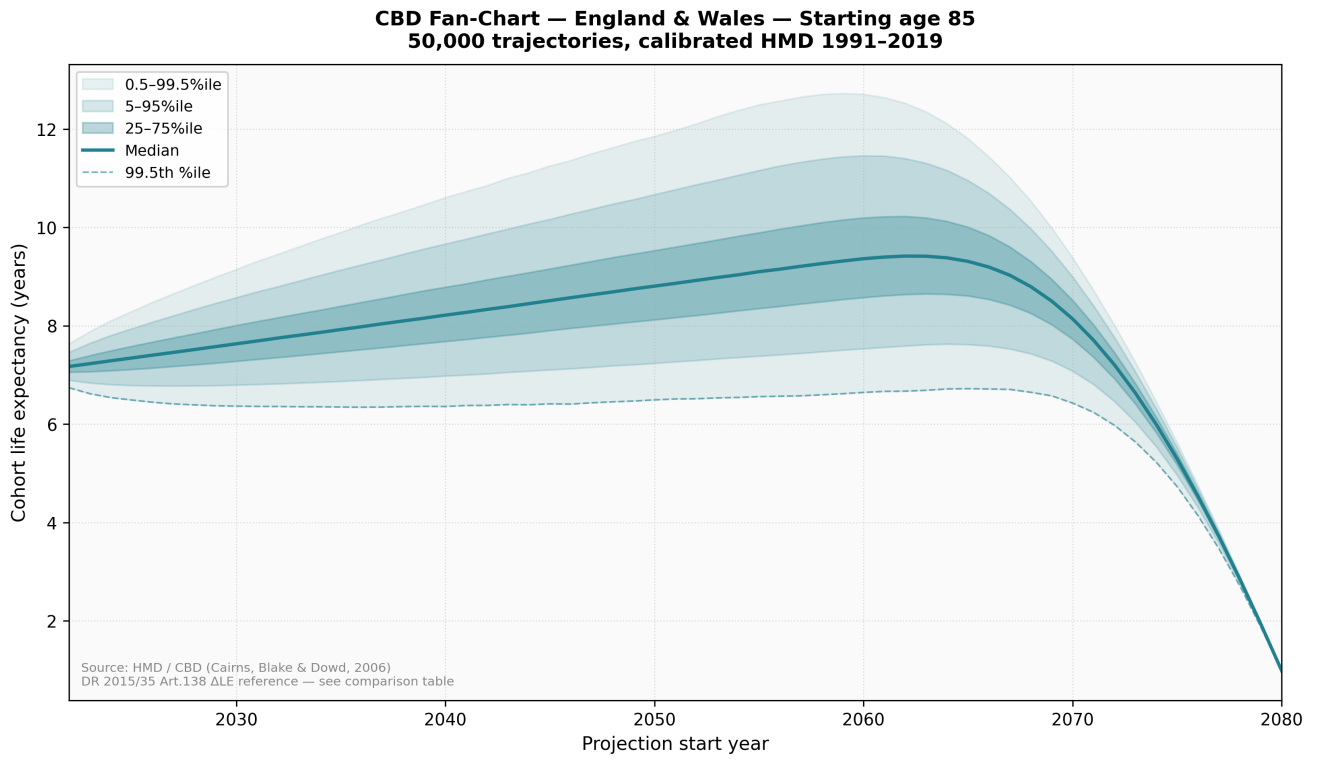


Figure A.4. CBD cohort LE fan-chart, England & Wales, starting age 85.

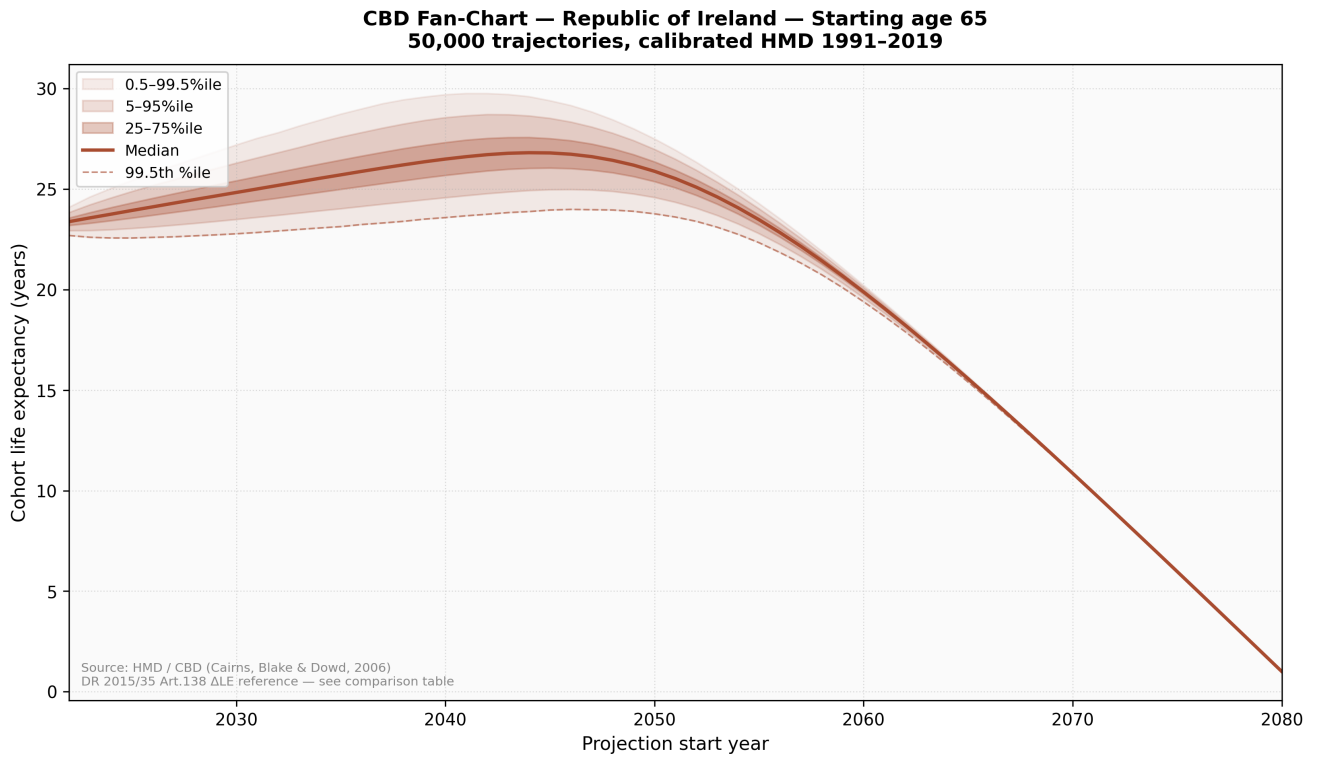


Figure A.5. CBD cohort LE fan-chart, Republic of Ireland, starting age 65.

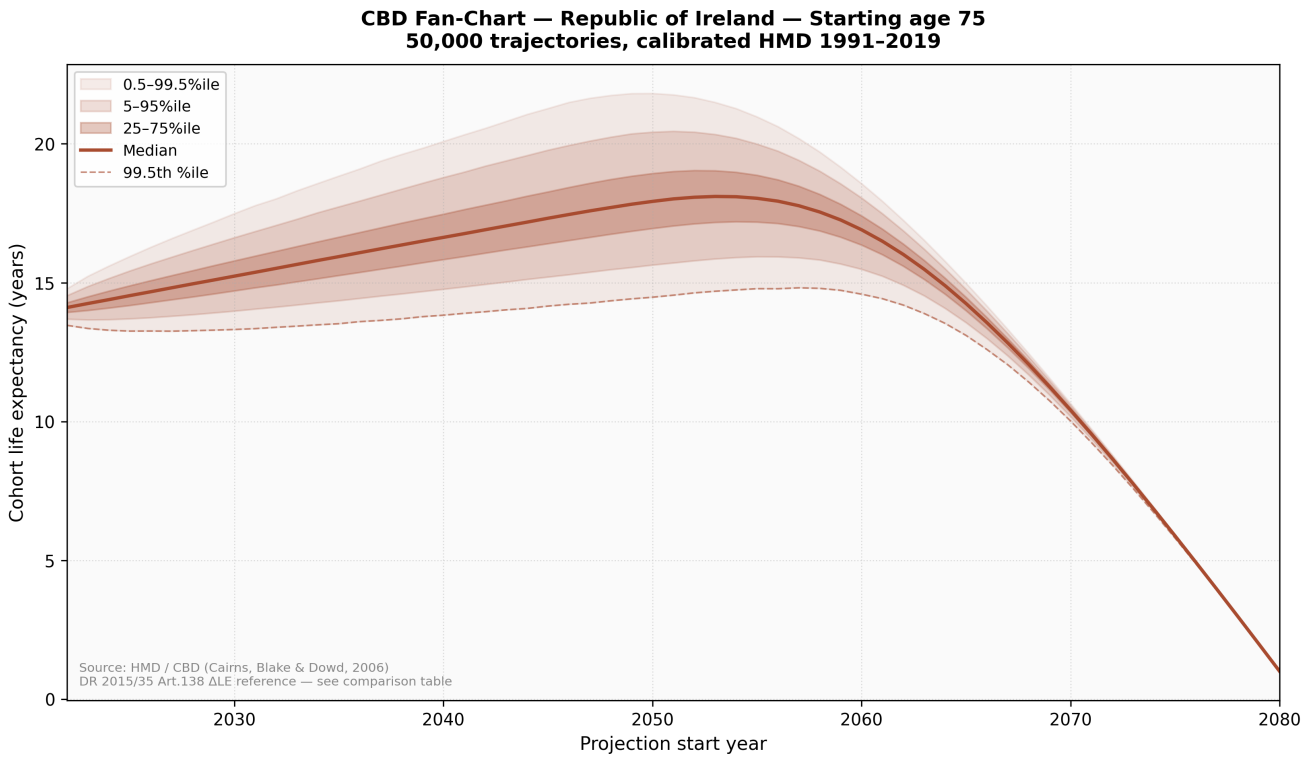


Figure A.6. CBD cohort LE fan-chart, Republic of Ireland, starting age 75.

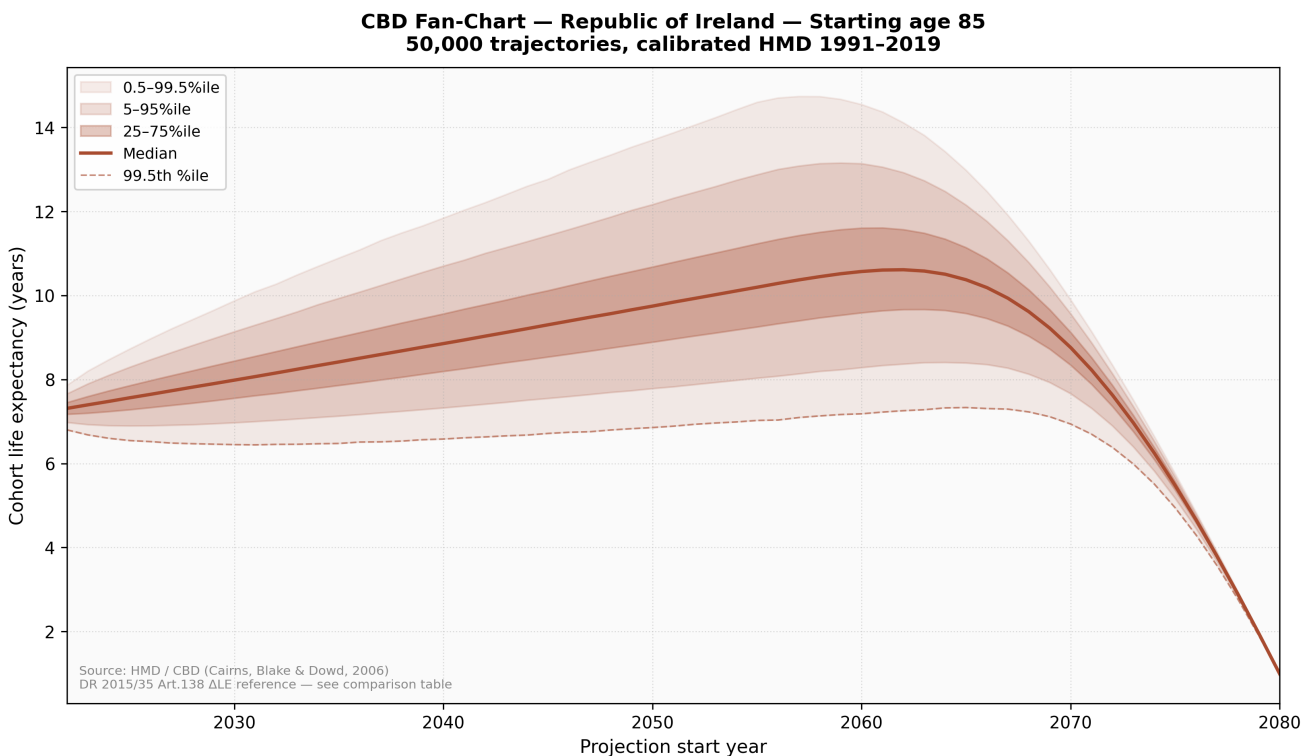


Figure A.7. CBD cohort LE fan-chart, Republic of Ireland, starting age 85.

A.6.3 Comparison table (single-source consistent)

The comparison table is reproduced from `/home/user/workspace/mwp4/phase_d_track1/outputs/comparison_table_v2.md`. All central LE values are the stochastic median of the 50,000-trajectory CBD simulation, consistent across percentiles, Article 138 deltas, and the headline JSON `/home/user/workspace/mwp4/phase_d_track1/outputs/article138_check_v2.json`.

CBD Life Expectancy Percentiles at Starting Age (Cohort commencing 2022)

Age	E&W Median	E&W 25/75	E&W 5/95	E&W 0.5/99.5	IRL Median	IRL 25/75	IRL 5/95	IRL 0.5/99.5	Gap (EW-IRL)
65	22.40	21.85 / 22.97	21.12 / 23.85	20.48 / 24.83	23.38	22.79 / 24.01	22.01 / 24.97	21.32 / 25.98	-0.98
75	13.61	13.24 / 14.01	12.75 / 14.61	12.31 / 15.27	14.10	13.71 / 14.52	13.19 / 15.16	12.71 / 15.84	-0.49
85	7.17	6.96 / 7.40	6.68 / 7.75	6.42 / 8.11	7.31	7.09 / 7.54	6.80 / 7.91	6.54 / 8.29	-0.14

Article 138 Stress (20% permanent decrease in $q_{\{x,t\}}$)

Central LE values below are the stochastic median (consistent with the percentile table above). Δ = stressed LE – stochastic median.

Base	Age	Central LE (stoch. median)	Stressed LE (Art.138)	Δ (years)	Art.138 percentile in CBD distribution
E&W	65	22.397	24.253	+1.856	97.9
E&W	75	13.614	15.193	+1.579	99.3
E&W	85	7.175	8.330	+1.155	99.9
Ireland	65	23.381	25.279	+1.898	97.3
Ireland	75	14.102	15.723	+1.621	99.2
Ireland	85	7.312	8.488	+1.176	99.9

CMI_2022 deterministic central reference: not available (closed-access model); CMI_2022 column is left unpopulated. See §A.7, Deviation-3.

A.7 Limitations and deviations from specification

Limitation 1 – Cross-jurisdictional assumption. The E&W and Ireland CBD calibrations are derived from different populations. The CMI_2022 model (which this annex benchmarks against) is itself calibrated to E&W data¹⁷. Application of CBD results to Irish pricing carries the assumption that Irish trend dynamics are adequately captured. The parallel Irish calibration directly tests this; the headline gap is approximately 1 year at age 65 (Ireland higher), and the parametric bootstrap in §A.4b.3 indicates the Irish-specific signal is not distinguishable from the E&W signal at conventional confidence levels.

Limitation 2 – Random-walk-with-drift assumption. Long-horizon projections (40+ years) extrapolate a 28-year fitted drift. The fan-chart cone widens proportionally. Structural breaks (post-2011 UK improvement slowdown, post-pandemic regime shift) are not modelled with regime-switching. The pandemic-exclusion calibration (drift from 1991–2019) is the working compromise.

Limitation 3 – No cohort effect. Cohort effects are omitted from the base case. The Renshaw–Haberman sensitivity (§A.5 item 4) tests robustness; it is not run in the present build.

Limitation 4 – Age extrapolation 90–110. Ages 90–110 are outside the calibration range (60–89). The linear logit model $\text{logit } q_{\{x,t\}} = \kappa_1(t) + \kappa_2(t) \cdot (x - 74.5)$ is applied by extrapolation. This is standard practice in the CBD literature but will over-estimate or under-estimate mortality at the oldest ages depending on the κ_2 trajectory. See Deviation-2 below.

Deviation-1 – Projection start (documented). Spec §A.3.4 discusses two options for the 2022 starting point. This build uses: start from κ_{2019} (last calibrated, pandemic-excluded) and apply three deterministic mean-drift steps to reach 2022, then begin the stochastic simulation. This is the “actuarially cleaner option” per the spec’s own wording.

Deviation-2 – Age extrapolation 90–110 (documented). As described in Limitation 4 above.

Deviation-3 — CMI_2022 not reproduced. CMI_2022 (Working Paper 177, June 2023)¹⁸ is a closed-access paid model. The CMI_2022 column in the comparison table is left unpopulated; the CBD stochastic median serves as the central reference in its place.

Deviation-4 — Horizon interpretation (documented). The specification requests LE at “horizons 10/20/30 years.” The projection script computes LE distributions for cohorts beginning in 2022 only. The comparison table reports LE for cohorts of ages 65, 75, 85 beginning in 2022, which implicitly captures horizons of roughly 20–45 years. Re-running full Monte-Carlo simulations for cohorts beginning in 2032, 2042 and 2052 is not run in the present build.

Deviation-5 — Fan-chart x-axis approximation (documented). Fan-charts show LE across projection starting years 2022–2080 by applying κ percentile paths (stored as percentile summaries from the 50,000-trajectory simulation) to deterministic forward LE from each starting year. This gives the correct shape of trend uncertainty across the fan; the 2022 starting-year slice is exact from the full MC simulation.

A.8 Sources

MYLIFE.IE · WORKING PAPER MWP-2026-04

ANNEX B

Full pricing and reserving surface

Complete numerical output from the pricing workbook, reproduced inline. The workbook remains the auditable source of truth; the tables below are the printed record.

Annex B – Full pricing and reserving surface

Complete numerical output from the workbook (*MWP-2026-04_Phase_F_Workbook_v05.1.xlsx*), reproduced inline. The workbook remains the auditable source of truth; the tables below are the printed record.

Reading the corners. The full surface below includes short-deferral / mid-age combinations where the commission-loaded premium is a large multiple of the equivalence-only fair-value premium. The Industry-reference loading peaks at 105.1% at the entry 72 / vesting 75 cell of Table B.3, extending the same pattern that Example 4 in §4 flagged at a 63% loading with the caveat that the 100% Y1 + 20% Y2–4 commission structure absorbs a disproportionate share of a short premium base and is not commercially plausible at those terms. Cells at these corners are included for completeness of the arithmetic surface; they are outside the commercially plausible band the six worked examples span.

B.1 Full 16×16 monthly-premium surface (Heaped+Trail default)

Monthly premium (€) required to secure €1,000/month lifetime income from the vesting date. Entry ages 60–75 (rows), vesting ages 75–90 (columns). Empty cells indicate infeasible combinations (vest ≤ entry).

Entry Vest	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
60	713.86	625.03	548.26	481.33	422.59	370.76	324.88	284.17	247.97	215.75	187.08	161.59	138.98	119.00	101.43	86.06
61	779.37	678.41	592.10	517.58	452.69	395.83	345.77	301.57	262.43	227.74	196.97	169.71	145.61	124.37	105.74	89.48
62	856.50	740.69	642.67	558.95	486.75	423.99	369.10	320.90	278.44	240.96	207.85	178.61	152.85	130.22	110.43	93.20
63	948.39	814.04	701.69	606.69	525.65	455.87	395.33	342.52	296.25	255.61	219.86	188.41	160.80	136.63	115.54	97.25
64	1,059.69	901.49	771.26	662.47	570.59	492.31	425.04	366.83	316.17	271.92	233.17	199.23	169.56	143.67	121.15	101.68
65	1,196.73	1,007.44	854.24	728.25	623.11	534.43	459.04	394.40	338.60	290.17	248.01	211.25	179.25	151.43	127.33	106.55
66	1,369.35	1,137.94	954.83	806.75	685.10	583.72	498.36	425.98	364.06	310.75	264.64	224.67	190.02	160.03	134.15	111.91
67	1,593.09	1,302.40	1,078.78	901.97	759.13	641.93	544.43	462.55	393.25	334.15	283.41	239.72	202.06	169.62	141.73	117.86
68	1,893.46	1,515.67	1,235.08	1,019.39	849.00	711.51	598.90	505.44	427.11	361.00	304.78	256.75	215.61	180.35	150.19	124.48
69	2,316.72	1,802.09	1,437.87	1,167.54	959.89	796.05	664.07	556.21	466.88	392.20	329.36	276.16	230.94	192.45	159.69	131.88
70	2,955.67	2,205.82	1,710.33	1,359.85	1,099.90	900.44	743.32	617.02	514.01	428.90	357.96	298.52	248.47	206.18	170.41	140.21
71	4,028.22	2,815.39	2,094.49	1,618.33	1,281.74	1,032.33	841.26	691.05	570.53	472.46	391.66	324.60	268.70	221.90	182.61	149.65
72	6,195.21	3,838.93	2,674.74	1,982.97	1,526.31	1,203.76	965.12	782.64	639.42	524.77	431.73	355.39	292.35	240.10	196.62	160.41
73	12,850.52	5,907.47	3,649.47	2,534.05	1,871.55	1,434.51	1,126.26	898.58	724.77	588.64	479.94	392.07	320.34	261.42	212.89	172.82
74	–	12,262.83	5,620.37	3,460.31	2,393.66	1,760.51	1,343.37	1,049.62	832.97	667.88	538.90	436.30	353.77	286.73	232.01	187.27
75	–	–	11,677.54	5,333.84	3,271.62	2,253.80	1,650.32	1,253.30	974.07	768.48	612.17	490.50	394.16	317.05	254.78	204.31

Table B.1. Full monthly-premium surface, Heaped+Trail default commission. Source: *surface_v07_heaped_trail_monthly_premium_for_1000_income.csv* in the workbook outputs.

B.2 Full 16×16 equivalence-only surface (zero loadings)

The same surface priced at pure equivalence with no commission, margin, or expense loadings. Difference between B.1 and B.2 equals the total loading impact under Heaped+Trail commission.

Entry Vest	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
60	584.92	513.16	450.64	395.76	347.31	304.33	266.10	232.02	201.62	174.47	150.23	128.63	109.42	92.42	77.43	64.30
61	636.20	555.34	485.56	424.84	371.61	324.68	283.15	246.29	213.54	184.39	158.45	135.41	114.98	96.94	81.07	67.21
62	695.90	604.06	525.49	457.77	398.92	347.40	302.07	262.06	226.65	195.27	167.44	142.80	121.02	101.84	85.02	70.36

Entry Vest	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
63	766.10	660.81	571.64	495.45	429.85	372.93	323.21	279.58	241.16	207.26	177.31	150.88	127.61	107.17	89.30	73.77
64	849.81	727.57	625.43	539.03	465.28	401.88	346.98	299.15	257.29	220.53	188.20	159.77	134.83	113.00	93.97	77.48
65	950.95	807.21	688.74	589.85	506.29	435.06	373.97	321.19	275.32	235.29	200.26	169.59	142.78	119.40	99.08	81.53
66	1,075.47	903.48	764.30	649.70	554.14	473.51	404.92	346.23	295.65	251.82	213.69	180.47	151.56	126.45	104.70	85.96
67	1,232.26	1,022.04	855.68	721.17	610.53	518.40	440.81	374.97	318.76	270.46	228.74	192.61	161.32	134.25	110.90	90.85
68	1,434.98	1,171.38	968.26	807.65	677.92	571.34	482.76	408.34	345.34	291.69	245.74	206.23	172.21	142.92	117.77	96.24
69	1,706.55	1,364.56	1,110.16	914.27	759.52	634.67	532.29	447.40	376.23	316.14	265.14	221.65	184.46	152.63	125.42	102.24
70	2,088.22	1,623.46	1,293.80	1,048.73	860.19	711.40	591.59	493.55	412.43	344.61	287.51	239.26	198.35	163.57	134.01	108.95
71	2,662.45	1,987.41	1,540.00	1,222.83	987.23	806.15	663.50	548.87	455.27	378.01	313.60	259.61	214.25	176.00	143.71	116.48
72	3,621.29	2,535.06	1,886.19	1,456.32	1,151.78	925.78	752.36	616.01	506.66	417.58	344.26	283.39	232.65	190.26	154.75	125.01
73	5,540.88	3,449.78	2,407.33	1,784.80	1,372.62	1,080.85	864.65	699.07	569.12	465.13	380.64	311.40	254.22	206.81	167.45	134.75
74	–	5,281.55	3,278.12	2,279.54	1,683.50	1,289.12	1,010.35	804.15	646.48	523.00	424.44	344.69	279.66	226.25	182.24	146.00
75	–	–	5,022.77	3,106.72	2,152.04	1,582.54	1,206.22	940.64	744.48	594.79	477.84	384.85	309.99	249.25	199.67	159.13

Table B.2. Equivalence-only surface (zero loadings). Source: surface_v07_heaped_trail_equivalence_only_for_1000_income.csv.

B.3 Full 7×4 headline panel – pricing (all four commission models)

Monthly premium (€) for €1,000/month lifetime income. Seven representative entry/vest combinations × four commission models.

Entry	Vest	Accum yr	Commission model	Monthly premium (€)	Annual premium (€)	Equivalence-only (€/mo)	Loading (€/mo)	Loading %
60	75	15	Heaped+Trail: 100% Y1 + 5% Y2+ (DEFAULT)	713.86	8,566.33	584.92	128.94	22.05%
			Zero commission (execution-only / fee-based)	618.82	7,425.89	584.92	33.91	5.80%
			Level 20% flat (comparator)	779.56	9,354.70	584.92	194.64	33.28%
			Industry reference: 100% Y1 + 20% Y2-4 + 3% Y5+ (comparator)	732.82	8,793.83	584.92	147.90	25.29%
60	80	20	Heaped+Trail: 100% Y1 + 5% Y2+ (DEFAULT)	370.76	4,449.18	304.33	66.44	21.83%
			Zero commission (execution-only / fee-based)	326.76	3,921.12	304.33	22.43	7.37%
			Level 20% flat (comparator)	411.63	4,939.59	304.33	107.30	35.26%
				377.10	4,525.20	304.33	72.77	23.91%

Entry	Vest	Accum yr	Commission model	Monthly premium (€)	Annual premium (€)	Equivalence-only (€/mo)	Loading (€/mo)	Loading %
			Industry reference: 100% Y1 + 20% Y2-4 + 3% Y5+ (comparator)					
60	85	25	Heaped+Trail: 100% Y1 + 5% Y2+ (DEFAULT)	187.08	2,244.94	150.23	36.85	24.53%
			Zero commission (execution-only / fee-based)	166.36	1,996.31	150.23	16.13	10.73%
			Level 20% flat (comparator)	209.57	2,514.83	150.23	59.34	39.50%
			Industry reference: 100% Y1 + 20% Y2-4 + 3% Y5+ (comparator)	189.34	2,272.08	150.23	39.11	26.03%
60	90	30	Heaped+Trail: 100% Y1 + 5% Y2+ (DEFAULT)	86.06	1,032.78	64.30	21.76	33.84%
			Zero commission (execution-only / fee-based)	76.91	922.96	64.30	12.61	19.61%
			Level 20% flat (comparator)	96.89	1,162.69	64.30	32.59	50.68%
			Industry reference: 100% Y1 + 20% Y2-4 + 3% Y5+ (comparator)	86.87	1,042.45	64.30	22.57	35.10%
63	75	12	Heaped+Trail: 100% Y1 + 5% Y2+ (DEFAULT)	948.39	11,380.73	766.10	182.29	23.79%
			Zero commission (execution-only / fee-based)	806.93	9,683.11	766.10	40.82	5.33%

Entry	Vest	Accum yr	Commission model	Monthly premium (€)	Annual premium (€)	Equivalence-only (€/mo)	Loading (€/mo)	Loading %
			Level 20% flat (comparator)	1,016.52	12,198.21	766.10	250.41	32.69%
			Industry reference: 100% Y1 + 20% Y2-4 + 3% Y5+ (comparator)	983.97	11,807.65	766.10	217.87	28.44%
63	80	17	Heaped+Trail: 100% Y1 + 5% Y2+ (DEFAULT)	455.87	5,470.44	372.93	82.94	22.24%
			Zero commission (execution-only / fee-based)	397.78	4,773.32	372.93	24.85	6.66%
			Level 20% flat (comparator)	501.10	6,013.15	372.93	128.17	34.37%
			Industry reference: 100% Y1 + 20% Y2-4 + 3% Y5+ (comparator)	466.19	5,594.33	372.93	93.27	25.01%
63	85	22	Heaped+Trail: 100% Y1 + 5% Y2+ (DEFAULT)	219.86	2,638.27	177.31	42.54	23.99%
			Zero commission (execution-only / fee-based)	194.22	2,330.59	177.31	16.90	9.53%
			Level 20% flat (comparator)	244.66	2,935.94	177.31	67.35	37.98%
			Industry reference: 100% Y1 + 20% Y2-4 + 3% Y5+ (comparator)	223.30	2,679.62	177.31	45.99	25.94%
63	90	27	Heaped+Trail: 100% Y1 + 5% Y2+ (DEFAULT)	97.25	1,166.98	73.77	23.48	31.83%
			Zero commission	86.46	1,037.57	73.77	12.69	17.21%

Entry	Vest	Accum yr	Commission model	Monthly premium (€)	Annual premium (€)	Equivalence-only (€/mo)	Loading (€/mo)	Loading %
			(execution-only / fee-based)					
			Level 20% flat (comparator)	108.92	1,307.06	73.77	35.15	47.65%
			Industry reference: 100% Y1 + 20% Y2-4 + 3% Y5+ (comparator)	98.42	1,181.09	73.77	24.66	33.42%
65	75	10	Heaped+Trail: 100% Y1 + 5% Y2+ (DEFAULT)	1,196.73	14,360.73	950.95	245.78	25.85%
			Zero commission (execution-only / fee-based)	998.92	11,987.07	950.95	47.97	5.04%
			Level 20% flat (comparator)	1,258.38	15,100.59	950.95	307.43	32.33%
			Industry reference: 100% Y1 + 20% Y2-4 + 3% Y5+ (comparator)	1,255.55	15,066.57	950.95	304.60	32.03%
65	80	15	Heaped+Trail: 100% Y1 + 5% Y2+ (DEFAULT)	534.43	6,413.18	435.06	99.37	22.84%
			Zero commission (execution-only / fee-based)	462.17	5,546.04	435.06	27.11	6.23%
			Level 20% flat (comparator)	582.21	6,986.57	435.06	147.15	33.82%
			Industry reference: 100% Y1 + 20% Y2-4 + 3% Y5+ (comparator)	549.24	6,590.85	435.06	114.18	26.24%
65	85	20	Heaped+Trail: 100% Y1 + 5%	248.01	2,976.08	200.26	47.75	23.85%

Entry	Vest	Accum yr	Commission model	Monthly premium (€)	Annual premium (€)	Equivalence-only (€/mo)	Loading (€/mo)	Loading %
			Y2+ (DEFAULT)					
			Zero commission (execution-only / fee-based)	217.87	2,614.42	200.26	17.61	8.80%
			Level 20% flat (comparator)	274.46	3,293.49	200.26	74.20	37.05%
			Industry reference: 100% Y1 + 20% Y2-4 + 3% Y5+ (comparator)	252.64	3,031.73	200.26	52.39	26.16%
65	90	25	Heaped+Trail: 100% Y1 + 5% Y2+ (DEFAULT)	106.55	1,278.56	81.53	25.02	30.69%
			Zero commission (execution-only / fee-based)	94.34	1,132.04	81.53	12.81	15.71%
			Level 20% flat (comparator)	118.84	1,426.08	81.53	37.31	45.77%
			Industry reference: 100% Y1 + 20% Y2-4 + 3% Y5+ (comparator)	108.07	1,296.86	81.53	26.55	32.56%
68	75	7	Heaped+Trail: 100% Y1 + 5% Y2+ (DEFAULT)	1,893.46	22,721.50	1,434.98	458.48	31.95%
			Zero commission (execution-only / fee-based)	1,501.87	18,022.47	1,434.98	66.90	4.66%
			Level 20% flat (comparator)	1,891.97	22,703.62	1,434.98	456.99	31.85%
			Industry reference: 100% Y1 + 20% Y2-4 +	2,049.91	24,598.91	1,434.98	614.93	42.85%

Entry	Vest	Accum yr	Commission model	Monthly premium (€)	Annual premium (€)	Equivalence-only (€/mo)	Loading (€/mo)	Loading %
			3% Y5+ (comparator)					
68	80	12	Heaped+Trail: 100% Y1 + 5% Y2+ (DEFAULT)	711.51	8,538.09	571.34	140.16	24.53%
			Zero commission (execution-only / fee-based)	603.54	7,242.51	571.34	32.20	5.64%
			Level 20% flat (comparator)	760.31	9,123.68	571.34	188.96	33.07%
			Industry reference: 100% Y1 + 20% Y2-4 + 3% Y5+ (comparator)	739.18	8,870.12	571.34	167.83	29.38%
68	85	17	Heaped+Trail: 100% Y1 + 5% Y2+ (DEFAULT)	304.78	3,657.41	245.74	59.04	24.02%
			Zero commission (execution-only / fee-based)	264.86	3,178.37	245.74	19.12	7.78%
			Level 20% flat (comparator)	333.66	4,003.91	245.74	87.91	35.77%
			Industry reference: 100% Y1 + 20% Y2-4 + 3% Y5+ (comparator)	312.30	3,747.55	245.74	66.55	27.08%
68	90	22	Heaped+Trail: 100% Y1 + 5% Y2+ (DEFAULT)	124.48	1,493.70	96.24	28.23	29.33%
			Zero commission (execution-only / fee-based)	109.36	1,312.30	96.24	13.11	13.62%
			Level 20% flat (comparator)	137.76	1,653.15	96.24	41.52	43.14%

Entry	Vest	Accum yr	Commission model	Monthly premium (€)	Annual premium (€)	Equivalence-only (€/mo)	Loading (€/mo)	Loading %
			Industry reference: 100% Y1 + 20% Y2-4 + 3% Y5+ (comparator)	126.77	1,521.27	96.24	30.53	31.72%
70	75	5	Heaped+Trail: 100% Y1 + 5% Y2+ (DEFAULT)	2,955.67	35,468.02	2,088.22	867.44	41.54%
			Zero commission (execution-only / fee-based)	2,180.83	26,169.98	2,088.22	92.61	4.43%
			Level 20% flat (comparator)	2,747.28	32,967.37	2,088.22	659.06	31.56%
			Industry reference: 100% Y1 + 20% Y2-4 + 3% Y5+ (comparator)	3,360.94	40,331.33	2,088.22	1,272.72	60.95%
70	80	10	Heaped+Trail: 100% Y1 + 5% Y2+ (DEFAULT)	900.44	10,805.32	711.40	189.04	26.57%
			Zero commission (execution-only / fee-based)	748.94	8,987.24	711.40	37.53	5.28%
			Level 20% flat (comparator)	943.47	11,321.58	711.40	232.06	32.62%
			Industry reference: 100% Y1 + 20% Y2-4 + 3% Y5+ (comparator)	946.07	11,352.85	711.40	234.67	32.99%
70	85	15	Heaped+Trail: 100% Y1 + 5% Y2+ (DEFAULT)	357.96	4,295.56	287.51	70.46	24.51%
			Zero commission (execution-only / fee-based)	308.08	3,696.98	287.51	20.57	7.16%

Entry	Vest	Accum yr	Commission model	Monthly premium (€)	Annual premium (€)	Equivalence-only (€/mo)	Loading (€/mo)	Loading %
			Level 20% flat (comparator)	388.10	4,657.23	287.51	100.60	34.99%
			Industry reference: 100% Y1 + 20% Y2-4 + 3% Y5+ (comparator)	368.70	4,424.45	287.51	81.20	28.24%
70	90	20	Heaped+Trail: 100% Y1 + 5% Y2+ (DEFAULT)	140.21	1,682.54	108.95	31.26	28.70%
			Zero commission (execution-only / fee-based)	122.38	1,468.57	108.95	13.43	12.33%
			Level 20% flat (comparator)	154.17	1,850.01	108.95	45.22	41.51%
			Industry reference: 100% Y1 + 20% Y2-4 + 3% Y5+ (comparator)	143.29	1,719.45	108.95	34.34	31.52%
72	75	3	Heaped+Trail: 100% Y1 + 5% Y2+ (DEFAULT)	6,195.21	74,342.49	3,621.29	2,573.92	71.08%
			Zero commission (execution-only / fee-based)	3,774.45	45,293.38	3,621.29	153.16	4.23%
			Level 20% flat (comparator)	4,754.82	57,057.89	3,621.29	1,133.54	31.30%
			Industry reference: 100% Y1 + 20% Y2-4 + 3% Y5+ (comparator)	7,427.51	89,130.06	3,621.29	3,806.22	105.11%
72	80	8	Heaped+Trail: 100% Y1 + 5% Y2+ (DEFAULT)	1,203.76	14,445.17	925.78	277.99	30.03%
			Zero commission	971.56	11,658.73	925.78	45.79	4.95%

Entry	Vest	Accum yr	Commission model	Monthly premium (€)	Annual premium (€)	Equivalence-only (€/mo)	Loading (€/mo)	Loading %
			(execution-only / fee-based)					
			Level 20% flat (comparator)	1,223.91	14,686.97	925.78	298.14	32.20%
			Industry reference: 100% Y1 + 20% Y2-4 + 3% Y5+ (comparator)	1,287.58	15,450.92	925.78	361.80	39.08%
72	85	13	Heaped+Trail: 100% Y1 + 5% Y2+ (DEFAULT)	431.73	5,180.79	344.26	87.47	25.41%
			Zero commission (execution-only / fee-based)	366.88	4,402.56	344.26	22.62	6.57%
			Level 20% flat (comparator)	462.17	5,546.08	344.26	117.91	34.25%
			Industry reference: 100% Y1 + 20% Y2-4 + 3% Y5+ (comparator)	447.78	5,373.31	344.26	103.52	30.07%
72	90	18	Heaped+Trail: 100% Y1 + 5% Y2+ (DEFAULT)	160.41	1,924.97	125.01	35.40	28.32%
			Zero commission (execution-only / fee-based)	138.90	1,666.79	125.01	13.89	11.11%
			Level 20% flat (comparator)	174.98	2,099.72	125.01	49.96	39.97%
			Industry reference: 100% Y1 + 20% Y2-4 + 3% Y5+ (comparator)	164.62	1,975.43	125.01	39.61	31.68%
75	80	5	Heaped+Trail: 100% Y1 + 5%	2,253.80	27,045.56	1,582.54	671.25	42.42%

Entry	Vest	Accum yr	Commission model	Monthly premium (€)	Annual premium (€)	Equivalence-only (€/mo)	Loading (€/mo)	Loading %
			Y2+ (DEFAULT)					
			Zero commission (execution-only / fee-based)	1,653.87	19,846.47	1,582.54	71.33	4.51%
			Level 20% flat (comparator)	2,083.45	25,001.40	1,582.54	500.91	31.65%
			Industry reference: 100% Y1 + 20% Y2-4 + 3% Y5+ (comparator)	2,565.21	30,782.51	1,582.54	982.67	62.09%
75	85	10	Heaped+Trail: 100% Y1 + 5% Y2+ (DEFAULT)	612.17	7,346.07	477.84	134.33	28.11%
			Zero commission (execution-only / fee-based)	505.43	6,065.13	477.84	27.59	5.77%
			Level 20% flat (comparator)	636.71	7,640.49	477.84	158.87	33.25%
			Industry reference: 100% Y1 + 20% Y2-4 + 3% Y5+ (comparator)	645.11	7,741.35	477.84	167.27	35.01%
75	90	15	Heaped+Trail: 100% Y1 + 5% Y2+ (DEFAULT)	204.31	2,451.73	159.13	45.18	28.39%
			Zero commission (execution-only / fee-based)	174.10	2,089.16	159.13	14.97	9.41%
			Level 20% flat (comparator)	219.32	2,631.80	159.13	60.19	37.82%
			Industry reference: 100% Y1 + 20% Y2-4 +	211.41	2,536.93	159.13	52.28	32.86%

Entry	Vest	Accum yr	Commission model	Monthly premium (€)	Annual premium (€)	Equivalence-only (€/mo)	Loading (€/mo)	Loading %
			3% Y5+ (comparator)					

Table B.3. 7x4 headline panel – all four commission models. 108 rows. Source: `panel_v07_7x4.csv`.

Rounding note. The monthly premium, annual premium, equivalence-only premium and loading columns are each an independent 2-decimal rounding of the unrounded engine output. Multiplying the displayed monthly premium by 12 will not always reproduce the displayed annual premium to the cent, because the annual figure is computed from the full-precision monthly value before rounding, not from the displayed monthly. The residual is at most €0.06 per row and is an artefact of display precision, not a data or arithmetic error. The auditable source at unrounded precision is `panel_v07_7x4.csv` (column headers `monthly_premium_eur`, `annual_premium_eur`).

B.4 Full 7x4 headline panel – reserving (Article 138 vs CBD 99.5%)

BEL, SCR, and Article 138 adequacy verdict for each entry/vest combination under Heaped+Trail default commission.

Entry	Vest	Monthly prem (€)	Monthly inc (€)	BEL central (€)	BEL Art.138 (€)	BEL CBD99.5 (€)	SCR Art. 138 (€)	SCR CBD99.5 (€)	Ratio	Verdict
60	75	713.86	1,000	-16,153	-8,707	-5,715	7,446	10,437	0.7134	inadequate
60	80	370.76	1,000	-9,297	-2,674	32	6,623	9,328	0.7099	inadequate
60	85	187.08	1,000	-5,037	475	2,788	5,512	7,826	0.7043	inadequate
60	90	86.06	1,000	-2,426	1,659	3,453	4,086	5,880	0.6949	inadequate
63	75	948.39	1,000	-19,678	-11,570	-8,304	8,108	11,374	0.7129	inadequate
63	80	455.87	1,000	-10,699	-3,511	-564	7,188	10,135	0.7093	inadequate
63	85	219.86	1,000	-5,606	353	2,865	5,959	8,471	0.7034	inadequate
63	90	97.25	1,000	-2,614	1,771	3,709	4,385	6,322	0.6936	inadequate
65	75	1,196.73	1,000	-23,206	-14,636	-11,179	8,569	12,026	0.7125	inadequate
65	80	534.43	1,000	-11,929	-4,348	-1,234	7,581	10,695	0.7088	inadequate
65	85	248.01	1,000	-6,073	194	2,845	6,268	8,918	0.7028	inadequate
65	90	106.55	1,000	-2,764	1,827	3,864	4,592	6,628	0.6927	inadequate
68	75	1,893.46	1,000	-32,559	-23,262	-20,350	9,297	12,209	0.7615	marginal
68	80	711.51	1,000	-14,568	-6,366	-3,750	8,202	10,817	0.7582	marginal
68	85	304.78	1,000	-6,977	-226	1,989	6,751	8,966	0.7530	marginal
68	90	124.48	1,000	-3,047	1,868	3,559	4,916	6,606	0.7441	inadequate
70	75	2,955.67	1,000	-46,146	-36,354	-33,867	9,792	12,279	0.7975	marginal
70	80	900.44	1,000	-17,241	-8,608	-6,376	8,633	10,865	0.7946	marginal
70	85	357.96	1,000	-7,788	-704	1,180	7,085	8,968	0.7900	marginal
70	90	140.21	1,000	-3,289	1,851	3,282	5,140	6,570	0.7822	marginal
72	75	6,195.21	1,000	-86,308	-76,031	-74,023	10,277	12,284	0.8366	marginal
72	80	1,203.76	1,000	-21,361	-12,277	-10,472	9,084	10,889	0.8343	marginal
72	85	431.73	1,000	-8,882	-1,444	75	7,438	8,957	0.8304	marginal
72	90	160.41	1,000	-3,593	1,781	2,929	5,374	6,522	0.8239	marginal
75	80	2,253.80	1,000	-34,871	-25,098	-24,019	9,773	10,852	0.9006	marginal
75	85	612.17	1,000	-11,437	-3,439	-2,532	7,998	8,905	0.8982	marginal
75	90	204.31	1,000	-4,239	1,508	2,189	5,747	6,428	0.8941	marginal

Table B.4. Reserving 7x4 panel — Article 138 vs CBD 99.5% cross-check under Heaped+Trail commission. 27 rows. Source: `reserving_v07_panel_7x4.csv`.

B.5 Six worked examples — reserving under all four commission models

For each of the six worked examples in §4, reserving diagnostics under each of the four commission models.

Ex #	Entry	Vest	Commission	Monthly prem (€)	BEL central (€)	BEL Art.138 (€)	BEL CBD99.5 (€)	SCR Art.138 (€)	SCR CBD99.5 (€)	Ratio	Verdict
1	60	80	heaped_trail	192.77	-4,834	-1,472	-97	3,362	4,736	0.7098	inadequate
1	60	80	zero	169.89	-881	2,521	3,909	3,401	4,789	0.7102	inadequate
1	60	80	level	214.02	-8,505	-5,180	-3,818	3,326	4,687	0.7095	inadequate
1	60	80	industry	196.06	-5,402	-2,046	-673	3,356	4,729	0.7098	inadequate
2	65	85	heaped_trail	248.01	-6,074	194	2,844	6,268	8,918	0.7028	inadequate
2	65	85	zero	217.87	-1,083	5,276	7,957	6,358	9,040	0.7034	inadequate
2	65	85	level	274.46	-10,454	-4,266	-1,643	6,188	8,811	0.7023	inadequate
2	65	85	industry	252.64	-6,841	-587	2,059	6,254	8,899	0.7027	inadequate
3	70	85	heaped_trail	357.96	-7,788	-703	1,180	7,085	8,968	0.7900	marginal
3	70	85	zero	308.08	-1,217	6,007	7,922	7,225	9,139	0.7905	marginal
3	70	85	level	388.10	-11,758	-4,758	-2,893	7,000	8,865	0.7897	marginal
3	70	85	industry	368.70	-9,203	-2,148	-271	7,055	8,931	0.7899	marginal
4	70	75	heaped_trail	1,496.82	-23,369	-18,416	-17,158	4,953	6,211	0.7974	marginal
4	70	75	zero	1,104.43	-1,820	3,243	4,525	5,062	6,344	0.7979	marginal
4	70	75	level	1,391.29	-17,574	-12,591	-11,326	4,982	6,247	0.7976	marginal
4	70	75	industry	1,702.07	-34,641	-29,745	-28,499	4,896	6,142	0.7972	marginal
5	60	85	heaped_trail	361.25	-9,727	1,207	5,796	10,934	15,524	0.7044	inadequate
5	60	85	zero	321.24	-1,889	9,163	13,792	11,051	15,681	0.7048	inadequate
5	60	85	level	404.68	-18,236	-7,429	-2,884	10,808	15,353	0.7039	inadequate
5	60	85	industry	365.61	-10,582	340	4,925	10,922	15,506	0.7043	inadequate
6	60	90	heaped_trail	86.06	-2,425	1,660	3,455	4,086	5,880	0.6949	inadequate
6	60	90	zero	76.91	-488	3,639	5,448	4,127	5,936	0.6953	inadequate
6	60	90	level	96.89	-4,718	-682	1,095	4,037	5,814	0.6943	inadequate
6	60	90	industry	86.87	-2,597	1,485	3,278	4,082	5,875	0.6948	inadequate

Table B.5. Reserving diagnostics for the six worked examples under all four commission models. 24 rows. Source: `reserving_v07_examples.csv`.

MYLIFE.IE · WORKING PAPER MWP-2026-04**ANNEX C**

Primary sources

All citations used in the working paper and annexes, grouped by topic, with full URLs to the primary source.

Annex C – Primary sources

C.1 Mortality

- CSO Irish Life Tables No.17, 2015–2017, published 2020: <https://www.cso.ie/en/releasesandpublications/er/ilt/irishlifetablesno172015-2017/>
- Society of Actuaries in Ireland – IILMI Longevity Investigation 2009–2015 (published March 2019): <https://web.actuaries.ie/>
- CMI Ltd. Working Paper 177 (CMI_2022 model, June 2023): <https://www.actuaries.org.uk/learn-and-develop/continuous-mortality-investigation>

C.2 Discounting

- EIOPA Risk-Free Interest Rate Term Structures, EUR no-VA, 31 May 2026 (published 3 June 2026): https://www.eiopa.europa.eu/tools-and-data/risk-free-interest-rate-term-structures_en

C.3 Loadings – Irish SFCRs year-end 2024

- Royal London Insurance DAC SFCR 2024: <https://www.royallondon.ie/siteassets/site-docs/about-us/sfcr/rl-ireland-sfcr-ye2024.pdf>
- Aviva Life & Pensions Ireland DAC SFCR 2024: <https://static.aviva.io/content/dam/aviva-public/ie/pdfs/aviva-life-pensions-ireland-sfcr-2024.pdf>
- Irish Life Assurance plc SFCR 2024: <https://www.centralbank.ie/docs/default-source/regulation/industry-market-sectors/insurance-reinsurance/solvency-ii/sfcr-2024/irish-life-assurance-plc-sfcr-2024.pdf>
- New Ireland Assurance Company plc SFCR 2024: <https://www.centralbank.ie/docs/default-source/regulation/industry-market-sectors/insurance-reinsurance/solvency-ii/sfcr-2024/new-ireland-assurance-company-plc-sfcr-2024.pdf>
- Zurich Life Assurance plc SFCR 2024: <https://www.zurich.ie/-/media/project/zurichie/zurichmainsite/files/sfcr-2024/sfcr-zurich-life-assurance-plc-2024.pdf>
- Standard Life International DAC SFCR 2024: <https://www.centralbank.ie/docs/default-source/regulation/industry-market-sectors/insurance-reinsurance/solvency-ii/sfcr-2024/standard-life-international-designated-activity-company-sfcr-2024.pdf>
- Milliman Ireland – Analysis of Solvency and Financial Condition Reports for Irish life insurers YE 2024 (May 2025): https://media.milliman.com/v1/media/edge/images/millimaninc5660-milliman6442-prod27d5-0001/media/Milliman/PDFs/2025-Articles/5-21-25_Ireland-SFCR-Report-YE-2024.pdf
- PwC Ireland – Insurance sector lapse risks (2024–2025): <https://www.pwc.ie/services/audit-assurance/insights/insurance-sector-lapse-risks.html>
- Society of Actuaries in Ireland – Financial and Economic Assumptions and Principles (March 2024): https://web.actuaries.ie/sites/default/files/2024-03/Financial%20%20Economic%20Assumptions%202024_final.pdf

C.4 Solvency II

- Directive 2009/138/EC (consolidated): <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:02009L0138-20210630>
- Commission Delegated Regulation (EU) 2015/35 (consolidated): <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02015R0035-20230101>
- EIOPA Rulebook, Article 55 (Lines of Business): https://www.eiopa.europa.eu/rulebook/solvency-ii/article-2468_en
- S.I. No. 485 of 2015 (Irish transposition): <https://www.irishstatutebook.ie/eli/2015/si/485>

C.5 Irish pensions law and Revenue

- Taxes Consolidation Act 1997, Part 30: <https://www.irishstatutebook.ie/eli/1997/act/39/>
- Revenue Pensions Manual Chapter 23 (ARFs): <https://www.revenue.ie/en/tax-professionals/tdm-wm/pensions/chapter-23.pdf>
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C.6 Consumer protection, IDD, PRIIPs

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- S.I. No. 80 of 2025 (CPC 2025 – Standards for Business): <https://www.irishstatutebook.ie/eli/2025/si/80/made/en/print>
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- PRIIPs Regulation (EU) No 1286/2014 (consolidated): <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02014R1286-20191230>
- EIOPA 2022 Technical Advice on the PRIIPs review (April 2022): https://www.eiopa.europa.eu/system/files/2022-04/esa_advice_on_the_review_of_the_priips_regulation.pdf

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- Criminal Justice (Money Laundering and Terrorist Financing) Act 2010: <https://www.irishstatutebook.ie/eli/2010/act/6/enacted/en/html>
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About the author

Donal Milmo-Penny, QFA FLIA, is the founder of Mylife.ie and Research Lead of the Mylife.ie Working Paper Series. He is a founding partner of SMP Financial Ltd, a financial services firm regulated by the Central Bank of Ireland (C42382). His public professional profile records twenty-five years of business experience in life assurance, pension and inheritance planning for Irish individuals, families, professionals and business owners. He has previously served as President / Chairman of the Professional Insurance Brokers Association (PIBA), as a Director of Brokers Ireland, and as a member and former Chair of Brokers Ireland's Legislation and Compliance

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Use of AI

This paper was drafted with the assistance of an AI research-and-writing tool acting under the direct supervision of the author. The tool was used to compile and synthesise the primary-source evidence reviewed throughout the paper, to execute the deterministic pricing, reserving and stochastic mortality calculations documented in §§3–6 and Annex A (full reproduction code is committed to the Mylife.ie research repository), and to draft the prose under the author's direction and review. All numerical results were independently verified against the model output documented in the companion workbook (MWP-2026-04_Phase_F_Workbook_v05.1.xlsx). All source citations were verified at the URLs given in Annex C. The author retains full editorial and professional responsibility for the paper's content, conclusions, and any errors of fact, interpretation, or judgement.

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