



Bridging the Health–Retirement Divide: An Actuarial, Technological and Policy Evaluation of NPS Swasthya under the PFRDA Regulatory Sandbox, with International Lessons for Viksit Bharat 2047

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ABSTRACT

India is experiencing a demographic transition which is intertwined with an unresolved vulnerability in household finances. Herein lies the possibility of an unforeseen and a catastrophic out-of-pocket healthcare expenditure (43.9 % of India's current health expenditure (World Bank, 2025a)) that erodes retirement savings precisely when it is most required. PFRDA, acting under its Regulatory Sandbox framework, has attempted to navigate this conundrum with a novel approach with the introduction of NPS Swasthya Pension Scheme as a Proof of Concept. This pension scheme has for the first time, incorporated a health insurance component, which is financed via a partial withdrawal of pension savings and provides members with the ability to exit the scheme completely and pay the health benefits administrator for inpatient treatments and procedures that are above the partial withdrawal ceiling. Despite these innovations, the scheme requires a policy framework within which it can be assessed and a pathway can be established towards a potential scaling. This paper aims to address this gap with three key components. First, it offers a joint longevity–morbidity framework that describes the health-embedded contingency within the NPS Swasthya scheme. Second, it employs a Monte Carlo simulation to estimate corpus erosion and replacement ratio under a withdrawal take-up behavior. Third, it draws on the cross-country experience of Singapore's MediSave, South Africa's Two-Pot system and the Health Savings Architecture in the United States to a graduation pathway from Sandbox to scale and a permissioned-ledger deployment architecture compatible with the Digital Personal Data Protection Act, 2023, towards a pensioned society and the vision of Viksit Bharat 2047 and Pension for All @ 2047.

Keywords: NPS Swasthya Pension Scheme, Health-Embedded Pension, Out-of-Pocket Healthcare Expenditure, Pension Adequacy and Longevity Risk

INTRODUCTION

India is in the middle of a slow demographic inversion. United Nations projections place the median age at roughly 29 years in 2025, climbing through mid-century, with the share of Indians aged sixty and above rising from about 11% in 2025 toward nearly one-fifth of the population by 2050 (United Nations, 2024). The window in which the country can translate its demographic dividend into a "second dividend" of accumulated pension capital is already closing. Yet the retirement readiness of Indian households is held back by something that pension policy has, until recently, treated as a separate problem: the out-of-pocket cost of healthcare.

Out-of-pocket payments financed 43.89 % of current health expenditure in India in 2023, down from 71.7 % in 2000 but still well above prevailing OECD benchmarks (World Bank, 2025a; OECD, 2025). The National Health Systems Resource Centre's National Health Accounts Estimates for India 2021-22 records the OOP share of Total Health Expenditure at 39.4 % in fiscal 2021-22, continuing the decline from 62.6 % in 2014-15 (Ministry of Health and Family Welfare & NHSRC, 2024). The gap is narrower than it appears, but both trajectories point the same way, and neither is yet at a level that removes health costs as a

corpus-erosion threat for retirees.

In per-capita purchasing-power-parity terms, direct household health outlays reached US\$151.95 in 2023, the highest real level in the available series (World Bank, 2025b). The most current authoritative Indian source on the household health-expenditure burden confirms that the morbidity gradient bites hardest at the ages where pension capital is most exposed: 43.9 % of persons aged sixty and above reported an illness in the fifteen days preceding the survey, against 22.5 % in the age band 45–59 and 13.1 % in the population at large; the population-wide illness-prevalence figure has roughly doubled from 7.5 % in the 75th Round (2017–18) to 13.1 % in 2025, a shift that may reflect higher reporting and healthcare access as well as actual disease burden growth. The average rate of inpatient hospitalisation in the year preceding the 80th-Round survey, excluding admissions for childbirth, was 2.9 per hundred persons (urban 3.2, rural 2.7), rising in published age bands from 1.5 % at ages 15–29 through 2.3 % at 30–44 and 4.2 % at 45–59 to 8.1 % at age sixty and above (MoSPI/NSO, 2025; PIB, 2026). The same survey also documents a structural shift in the surrounding insurance market: the share of persons covered by some form of health insurance has risen from approximately 14% rural and 19% urban in 2017–18 to approximately 47% rural and 44% urban in 2025, with government-sponsored schemes accounting for the bulk of that expansion wherein rural coverage under government schemes alone rose from 12.9 to 45.5 % over the same window (PIB, 2026). The disease mix is also shifting: the 80th Round reports a decline in infectious diseases against a rise in non-communicable conditions that bear directly on the long-horizon morbidity exposure that NPS Swasthya is intended to absorb. The Ageing Study in India had earlier found that a substantial minority of elderly Indians with an inpatient episode resorted to borrowing or asset sales (IIPS et al., 2020) and the 2025 Global Monitoring Report on Universal Health Coverage estimates that 26 % of the global population incurred financial hardship from out-of-pocket health spending in 2022 (World Health Organization & World Bank, 2025). The two trends sit awkwardly together and define the policy puzzle that NPS Swasthya engages in. Insurance breadth has roughly tripled in rural India in seven years, yet the OOP share of current health expenditure remains above 40% and the elderly carry the heaviest residual exposure. When a retirement corpus and a medical emergency collide in the same household, the corpus almost always loses. Ageing, rising chronic-disease prevalence and medical inflation running ahead of consumer prices have made that collision a routine feature of Indian old age (NITI Aayog, 2024); the Economic Survey 2025-26 flags pension-funding sustainability and healthy life expectancy (12.9 years at age sixty) as twin policy hinges for Viksit Bharat 2047 (Ministry of Finance, 2026).

Against this backdrop, PFRDA has launched, through two successive proof-of-concept circulars under its Regulatory Sandbox framework, the NPS Swasthya Pension Scheme which is the first Indian pension product to embed mandatory health insurance within the NPS architecture, to finance the premium directly from the subscriber's retirement corpus and to permit a one-hundred-per-cent premature exit for inpatient expenses remitted directly to the Health Benefit Administrator (PFRDA, 2026a, 2026b). The novelty is unmistakable; the analytical lacuna that surrounds it is equally so. We argue that NPS Swasthya is a substantive innovation whose actuarial, behavioral, technological and architectural implications have not yet been formally evaluated and that the absence of graduation criteria from Sandbox to scale risks both the underutilization of a good instrument and the premature commitment to a flawed one. The paper offers a three-part framework which are joint longevity–morbidity pricing, stochastic corpus-erosion projection, and a permissioned-ledger deployment architecture compatible with the Digital Personal Data Protection Act.

2. Literature Review

Three strands of literature converge on the problem that NPS Swasthya attempts to solve. The first concerns retirement-income adequacy in India. The NPS, although architecturally modern, delivers replacement ratios that are generally below the ILO's social-protection floor for subscribers who begin contributing late or at modest levels (Noorul, 2024; OECD, 2025). The APY fills part of the low-income gap but caps the guaranteed monthly pension at five thousand rupees (PFRDA, 2025). These findings explain why PFRDA has in recent years prioritized product innovation, launching NPS Vatsalya for minors in September 2024 (PIB, 2024) and now, Swasthya for the pension–health intersection.

The second strand examines the convergence of health financing and retirement savings. The canonical reference is the United States Health Savings Account literature: paired with a high-deductible plan, HSAs can function as a long-horizon accumulation vehicle with a triple tax advantage under specific behavioral conditions (IRS, 2024, 2025). Empirical evidence tempers the claim wherein the average HSA balance was US\$4,747 in 2023 and only about one in seven accountholders invests, rather than holding cash (Fronstin & Roebuck, 2024). In the social-insurance tradition, Germany's Pflegeversicherung (contribution rate 3.6 % of gross pay from 1 January 2025) and Japan's Kaigo Hoken (parallel contributions from age forty) show that a separate contributory stream can finance old-age health needs without raiding the pension base (BMG, 2025; MHLW, 2019). Thus, the design question remains if the health contribution ought to be

ring-fenced or share a single corpus?

Reference is to be drawn to the Indian evidence on catastrophic health spending wherein Pandey et al. (2018), using successive NSSO consumption rounds, find that the share of households experiencing catastrophic health expenditure rose from 11.1 % in 1995-96 to 24.9 % in 2014 which is a 2.24-fold increase, with the poorest decile deteriorating three-fold against the richest decile's 1.74-fold. Kastor and Mohanty (2018) extend the analysis to disease-specific burden, documenting that approximately 79 % of cancer hospitalizations generate catastrophic spending. These two papers calibrate the tail of the distribution that NPS Swasthya's clause 4(c) premature-exit mechanism is intended to catch; they also quantify the amount of pre-retirement wealth at risk of being routed to inpatient episodes if a dedicated financing rail is not provided. The headline indicators from the NSS 80th Round Survey on Household Social Consumption: Health supersede the 75th Round (2017-18) data that previously anchored these calibrations and reset the empirical baseline against which NPS Swasthya's actuarial assumptions should be tested (MoSPI/NSO, 2025; PIB, 2026).

The third strand addresses the behavioral economics of early withdrawal. The Center for Retirement Research estimates that aggregate 401(k) and IRA retirement wealth in the United States is at least 20 % lower than it would be absent leakage (Munnell & Webb, 2015; see also Argento et al., 2015). The early withdrawals permitted under Chile's AFP system in 2020 and 2021, totaling approximately US\$51.8 billion (Superintendencia de Pensiones, 2022); under South Africa's Two-Pot retirement system from 1 September 2024, which generated gross pay-outs of R43.42 billion within roughly five months (Cranston, 2025; National Treasury, 2023) and under Australia's COVID Early Release Scheme, which approved about 4.55 million applications for roughly A\$37.8 billion in 2020 (ATO, n.d.-b), confirm a common pattern: uptake has exceeded actuarial projections, with the heaviest participation clustered among low-income members whose replacement-ratio buffer was already thin. The behavioral literature attributes these patterns to mental accounting, present bias and the difficulty of valuing a distant old age against a proximate cash need (Benartzi & Thaler, 2013).

Regulatory-sandbox scholarship forms a connecting thread. Zetzsche, Buckley, Barberis and Arner (2017) built the seminal taxonomy of sandbox designs and argued that the hard governance question is exit, not admission. Cornelli, Doerr, Gambacorta and Merrouche (2024) provide quasi-experimental evidence that admission to the FCA Sandbox raises post-admission capital raised by approximately 15% and increases the probability of raising capital by about fifty percentage points. Jenik and Lauer (2017) identify opaque graduation criteria as the most common failure mode of sandboxes in emerging markets. The Financial Conduct Authority moved its Sandbox to an "always-open" rolling-application model in August 2021 following the Kalifa Fintech Strategic Review (FCA, n.d.); The Pensions Regulator in the United Kingdom launched a complementary Innovation support service for trust-based pension schemes (TPR, 2025). India's regulatory-sandbox experience across RBI, SEBI, IRDAI and IFSCA is now coordinated through the Inter-operable Regulatory Sandbox. NPS Swasthya is the first product-sandbox exercise pursued principally under PFRDA and is therefore, a natural case study for the adequacy of Indian sandbox practice. A final observation is that there is no peer-reviewed or published working-paper treatment of NPS Swasthya exists at the time of writing. This paper is the first academic evaluation of the scheme.

3. The PFRDA Regulatory Sandbox: Architecture

The PFRDA Regulatory Sandbox (PFRDA, 2022) was operationalised through the Inter Operable Regulatory Sandbox Framework as a "formal regulatory program for market participants intended to test new products, modified variants, services or creative business models with users in an environment, subject to certain safeguards, reasonable caution and adequate oversight". The circular required any proposed innovation to "invariably include new or emerging technology or use of existing technology in an innovative way and ... necessarily address a problem, fill a void and bring benefits to consumers." PFRDA also participates in the Inter-operable Regulatory Sandbox wherein hybrid products spanning multiple regulators are processed under a Principal Regulator with the others acting as Associate Regulators and the Principal Regulator's eligibility criteria apply (RBI, 2025). The coordination is critical for a pension-plus-health hybrid such as NPS Swasthya because the health-insurance component sits under IRDAI. The Sandbox therefore operates on two axes simultaneously which comprises of an own-account axis under PFRDA jurisdiction and a cross-sectoral axis through IoRS.

4. NPS Swasthya: Anatomy of PoC-1 and PoC-2

NPS Swasthya under PoC-1, authorizing ICICI Prudential Pension Funds Management Company to launch "NPS Swasthya Equity Plus" as the first scheme under the Sandbox's pension-health product category (PFRDA, 2026a). PoC-1 established the core architecture wherein a subscriber holds a standard NPS account supplemented by a health-insurance layer administered by a designated Health Benefit Administrator, Third Party Administrator or Health Tech Company in partnership with the Pension Fund. The CRA continues to record contributions and units, while claims flow through the health administrator

in accordance with applicable IRDAI Regulations.

The scheme runs on two accounts, not one. PoC-1 Annexure I, clause 1 requires that "a Common Scheme Account shall mandatorily be opened along with the NPS Swasthya Pension Scheme Account, if not already available." The subscriber therefore holds two registered pots of pension capital at the same time. The Swasthya account is where fresh contributions flow and from which the mandatory health-insurance premium is deducted as a partial withdrawal. The Common Scheme Account is the destination for any residual at exit and the holding place for corpus that ceases to be eligible for Swasthya treatment. The two accounts are not connected symmetrically. Under PoC-1, subscribers above the age of forty (other than those in the government sector and government-owned corporates) may transfer up to 30% of their self and employee contributions from the Common Scheme Account into the Swasthya account which is a one-way top-up channel aimed at the age group most exposed to inpatient morbidity risk. In the other direction, the Swasthya account is a closed loop while the subscriber stays in the scheme; on every termination event (voluntary discontinuation, scheme-level wind-down, or the clause 4(c) catastrophic-exit trigger discussed below), the remaining corpus is moved into the Common Scheme Account. The first PoC-1 launch under the scheme, ICICI Prudential Pension Funds' "NPS Swasthya Equity Plus", runs the architecture with an equity-tilted investment universe (70 to 100 % equity, up to 30 % debt, up to 10 % money-market), a fund-level total expense ratio of 0.30 % of assets per annum and a fifteen-year minimum vesting period before non-medical exit becomes available (ICICI Prudential Pension Funds, n.d.). The PoC-2 extends the design to three dimensions. Clause 4(a) makes the health-insurance benefit mandatory and stipulates that "the premium for such insurance top up shall be deducted as a partial withdrawal from the subscriber's NPS Swasthya Scheme account." The bundling resolves the adverse-selection concern of voluntary pension-health hybrids. Clause 4(b) sets the entry threshold: "the minimum initial contribution for onboarding shall be Rs. 25,000 (Rupees Twenty-Five Thousand only). A subscriber shall become eligible to avail benefits under NPS Swasthya Pension Scheme upon such contribution."

The deduction mechanic in clause 4(a) interacts non-trivially with the partial-withdrawal regulation that NPS subscribers face under the extant Exits and Withdrawals Regulations: the cap is "25% (twenty-five percent) of the subscriber's own contributions made to the Scheme" (PFRDA, 2026a, Annexure I, clause 6). At onboarding, that cap binds at twenty-five % of twenty-five thousand rupees, or six thousand two hundred and fifty rupees. Our Monte Carlo simulation, which uses an indicative actuarial ladder rising from approximately six thousand rupees for entrants under thirty-five to twenty-two thousand at age fifty-five and above, therefore overstates the early-year premium that can in fact be collected from a young entrant who contributes only the minimum and understates the duration over which the binding ceiling distorts premium adequacy for older entrants. The implication for product design is direct: the deduction rule should be specified as the lesser of the actuarial premium and the partial-withdrawal cap. PoC-1 Annexure I clause 6 additionally conditions the first partial withdrawal on a minimum accumulated corpus of fifty thousand rupees, so a minimum-contribution entrant cannot trigger any premium deduction in contribution year one and the actuarial premium ladder effectively shifts forward by one year.

Clause 4(c) of PoC-2 then authorizes a 100% premature exit "in case of inpatient medical treatment where medical expenses in a single instance exceed the subscriber's eligible limit for partial withdrawal," with proceeds remitted directly to the Health Benefit Administrator and "any excess amount, after settlement of the medical expenses, ... transferred to the subscriber's Common Scheme Account." The exit amount is the same as under PoC-1 but the trigger threshold has been recalibrated downwards. For an early age subscriber whose corpus is small but whose own contributions are smaller still, this is a substantial loosening of the catastrophic-exit door: an inpatient episode that would have fallen well short of 70% of accumulated corpus under PoC-1 may now exceed 25% of own contributions and authorize full exit under PoC-2. The route remains binary in either regime wherein the subscriber either continues to accumulate or transitions to a fully withdrawn state, with no intermediate continuation pathway for NPS Swasthya. However, a subscriber who triggers clause 4(c) retains a Common Scheme Account balance, to which any residual after settlement is transferred and may continue to contribute to an NPS All Citizen model but cannot re-enter Swasthya. The re-entry question is taken up as a policy recommendation in Section 8.2.

Clause 5 preserves the Sandbox perimeter wherein it states that "Pension Funds may launch the NPS Swasthya Pension Scheme (PoC-2), subject to prior approval of the Authority, in collaboration with one Central Recordkeeping Agency (CRA) and one Health Benefit Administrator / Third Party Administrator / Health Tech Company, for a limited duration and with restricted subscriber enrolment, under the Regulatory Sandbox approach." Clause 6 clarifies that schemes already operational under PoC-1 continue on their original terms, creating a two-tier sandbox cohort which will be informative for any eventual graduation decision.

In brief, NPS Swasthya is a bundled pension-plus-health product structured around a dual-account architecture with specific Sandbox deviations from the standard NPS framework which are mandatory insurance funded from the retirement corpus subject to a binding partial-withdrawal ceiling in early

years, reduced minimum onboarding and a full-corpus exit trigger for catastrophic inpatient episodes coupled with direct remittance to the health administrator and residual transfer to the Common Scheme Account. The scheme launches into a market where standalone health-insurance coverage has roughly tripled in rural India and more than doubled in urban India over seven years (MoSPI/NSO, 2025; PIB, 2026). That changes how NPS Swasthya should be positioned. The product fits best as a mix of old age income and healthcare security wherein its distinctive offering is the corpus-linked top-up that finances out-of-pocket exposure once the standalone cover has been exhausted.

5. International Precedents

Some international comparators are present in the NPS Swasthya product design space. Singapore's Central Provident Fund integrates a dedicated MediSave sub-account with the main retirement account, requires mandatory MediShield Life coverage whose premiums are auto debited from MediSave and channels any MediSave balance above the Basic Healthcare Sum into the Special or Retirement Account (CPF, 2026; MOH Singapore, 2015). The design is the cleanest global instance of a lifecycle pension-health account: ring-fenced during accumulation, convertible into retirement capital at the transition point.

South Africa's Two-Pot system split new contributions into a one-third savings pot accessible annually above a two-thousand-rand minimum and a two-thirds retirement pot preserved until retirement (National Treasury, 2023). South African Revenue Service data released in early 2025 recorded 2.66 million tax-directive applications within the first five months, of which 2.40 million were approved, yielding gross pay-outs of R43.42 billion, with medical and household-debt motives featuring prominently (Cranston, 2025). The policy lesson to infer is that an early-access door, once opened under a crisis framing, is difficult to narrow later and take-up tends to cluster among members whose pension is already least adequate.

In the United States, the Health Savings Account created under Internal Revenue Code permits a triple-tax-advantaged accumulation vehicle when paired with a high-deductible health plan. Average HSA balances of only US\$4,747 in 2023 and low rates of investment migration, suggest that without employer defaults and automatic escalation the intended behavioral outcome is not realized (Fronstin & Roebuck, 2024). The lesson for NPS Swasthya is that choice architecture comprising of the combination of defaults and nudging towards escalation will decide whether the scheme functions as designed or not.

Two technology-side precedents anchor the deployment-architecture argument in Estonia's e-Health record exchange which has shown that a national health-data platform can achieve tamper-evidence and regulator-auditability without exposing patient-level records on a public chain. The Synaptic Health Alliance has run a permissioned-blockchain pilot since 2018 to reconcile provider-directory data across members. Neither pilot is a direct analogue to NPS Swasthya, but both establish that permissioned distributed-ledger rails are a live production technology in health finance (Kuo et al., 2017; Zhang et al., 2018).

6. Research Gaps

Three gaps emerge from literature and precedent analysis. First, no published actuarial pricing framework captures the embedded health-contingent put option that clause 4(c) grants which is the right to exit the corpus at 100% when a contingent claim exceeds the partial-withdrawal cap; the joint distribution of longevity, morbidity and lapse has not been modelled in the Indian context. Second, no projection quantifies NPS-Swasthya-specific corpus erosion or replacement-ratio impact under varying withdrawal behaviors and none has examined how the year-one partial-withdrawal ceiling discussed in Section 4 distorts effective premium pricing for older entrants. Third, no deployment-layer analysis has been published of it and under what conditions, a permissioned distributed-ledger architecture would add supervisory and reconciliation value over conventional integration with extant claim-routing infrastructure; subscriber protection rests on generic grievance channels with no sandbox-cohort-specific ombudsman or compensation pool. The framework that follows addresses these gaps directly.

7. A Three-Part Solution Framework

7.1 Joint Longevity-Morbidity Pricing Schema

PoC-2 clause 4(c) converts the NPS Swasthya corpus from a pure longevity-contingent claim into a longevity-and-morbidity-contingent claim. A tractable pricing schema should therefore separate three risk layers. The first is the accumulation-phase investment return, modelled as a weighted lognormal draw across NPS Scheme E, C and G under the current lifecycle allocation. The second is the morbidity layer which is an age-specific probability of an inpatient episode, conditional on which a severity distribution governs out-of-pocket exposure net of the bundled insurance cover. The third is the lapse layer, which is the behavioral probability that a subscriber, conditional on an out-of-pocket charge exceeding the eligible partial-withdrawal cap, elects the one-hundred-per-cent premature exit rather than seeking alternative

financing. Pitacco's (2019) frailty-aware mortality framework is mathematically compatible with the morbidity layer used here. Levantesi and Menzietti (2018) formalize the same intuition in the long-term care setting, showing that a product mix of annuity and morbidity exposure can reduce reserve volatility through natural hedging, with the size of the effect depending on the long-term-care-to-annuity mix and the chosen risk metric, which reinforces the case for bundled rather than stand-alone pricing. Denuit et al. (2017) supply the medical-inflation indexation mechanism for lifelong contracts that the premium ladder in Section 7.2 implicitly invokes.

Our Monte Carlo model operationalizes the schema with explicit, replicable parameters. Asset returns are drawn from a lognormal process from PFRDA's aggregate NPS returns over FY2014–FY2024 which comprises of an equity return of 11.5 % with 17.5 % volatility, a corporate-bond return of 8.2 % with 5.5 % volatility and a government-securities return of 7.2 % with 4.5 % volatility, weighted by the LC-50 default lifecycle glide path (equity allocation of 50% under age thirty-five, 10% beyond 55). Age-specific inpatient hospitalization probability is taken directly from the NSS 80th Round which is 2.0 % for ages 25–34 (interpolated across the published 15–29 and 30–44 buckets), 2.3 % for 35–44 (published 30–44 bucket), 4.2 % for both 45–54 and 55–59 (published 45–59 bucket) and 8.1 % for the age-60+ band where Figure 4 of the model uses entry-age-driven heatmap cells (MoSPI/NSO, 2025; PIB, 2026). The NSS-defined hospitalization rate excludes admissions for childbirth, which is consistent with our model's treatment. The pre-recalibration ladder (3.5 / 4.2 / 5.8 / 8.5) was derived from LASI Wave 1 elderly rates and NSSO 75th Round (2017–18) working-age rates and overstated the 2025 baseline by roughly a factor of two; the recalibrated ladder anchored on the published 80th Round bands correct that bias without disturbing the headline drag finding. Conditional on an inpatient episode, severity is drawn from a lognormal distribution with a median of twenty-seven thousand rupees and a 95th percentile above three lakhs. The NSS 80th Round reports an average household out-of-pocket expenditure per hospitalization case of ₹34,064 across all institutional categories, with private hospitals (including PMJAY-empaneled providers) at ₹50,508 average and ₹24,000 median and public hospitals at ₹6,631 average and ₹1,100 median (MoSPI/NSO, 2025; PIB, 2026). Our severity is the gross episode cost (pre-insurance) and is not directly comparable to the NSS post-insurance OOP, but the private-hospital median of ₹24,000 sits close to our model median of ₹27,000, indicating that the severity calibration is well anchored for the private-hospital case that is most relevant to clause 4(c) trigger episodes. Insurance cover is set at five lakh rupees to mirror the PMJAY family floater (NHA, n.d.). The annual Swasthya premium follows an indicative age-banded ladder which is six thousand rupees under thirty-five rising to twenty-two thousand at age 55 and above, is deducted as a partial withdrawal per PoC-2 clause 4(a) and capped, in any year, by 25% of cumulative own contributions.

The joint lapse rule operates on the intersection of morbidity severity and the subscriber's pre-existing partial-withdrawal headroom. The only episodes whose net out-of-pocket exposure exceeds the cap are eligible to trigger clause 4(c) and even among those, triggering is probabilistic with a behavioral take-up parameter varied across scenarios from 25 to 75 %. Replacement-ratio impact is computed using the IALM 2012-14 life table, with an annuity factor of 12.8 at age sixty and the erstwhile NPS 40/60 annuitization-to-lumpsum split. This parametrization is structurally conservative wherein equity returns are trailing, hospitalization rates are consistent with primary survey sources, and the insurance cover is a conservative floor, so the results that follow can be read as lower bounds on the size of the corpus-erosion channel.

7.2 Stochastic Corpus-Erosion Projection

Applying this schema through a Monte Carlo simulation of ten thousand paths across three subscriber archetypes wherein the entry is at age thirty-five with an annual contribution of fifty thousand rupees, at age forty-five with one lakh and at age fifty-five with one and a half lakh, *ceteris paribus* in a given scenario, produces three principal findings.

Even with modest health-withdrawal take-up, the mandatory-premium drag alone reduces the median terminal corpus at age sixty by approximately 22% for the age-thirty-five archetype, 16% for the age-forty-five archetype and 14% for the age-fifty-five archetype. The percentage drag is regressive wherein it falls most heavily on the youngest, lowest-contribution archetype, whose accumulation horizon offers the most time for the deducted premium to compound away. The accumulation-path chart traces the same mechanism in continuous time. The Swasthya path separates from the baseline NPS path by year three or four for the age-thirty-five archetype and by year two for older entrants and the gap then compounds through the residual investment horizon.

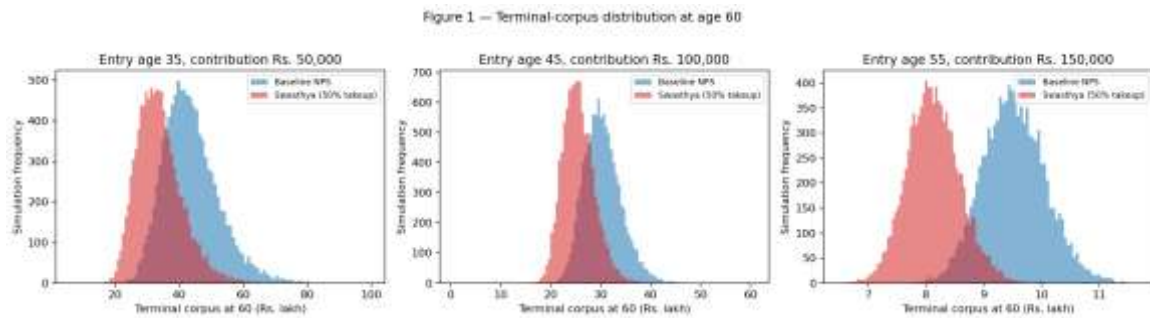


Figure 1 — Terminal-corpus distribution at age 60, baseline NPS vs Swasthya (50% take-up).

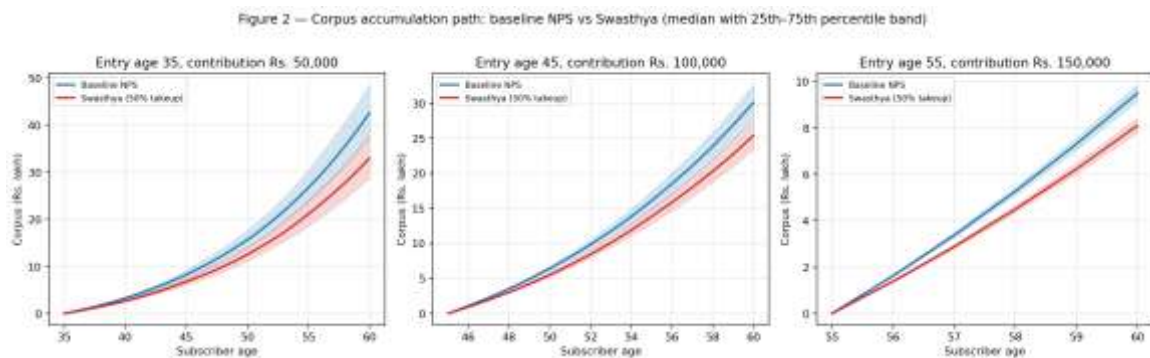


Figure 2 — Corpus accumulation path from entry to age 60, baseline NPS vs Swasthya (50% take-up): median (line) with 25th–75th percentile band (shaded) for each subscriber archetype.

Translated into replacement-ratio space, the median annuity-based replacement ratio falls from approximately 22% to 17% for the age-thirty-five archetype at fifty-per-cent take-up, from about 8% to 7% for the age-forty-five archetype and from one-and-a-half % to one-and-a-third % for the age-fifty-five archetype. The distributional spread is wide: the 5th–95th percentile band straddles the median by a factor of two to three, indicating that a minority of subscribers face replacement-ratio outcomes well below the central tendency.

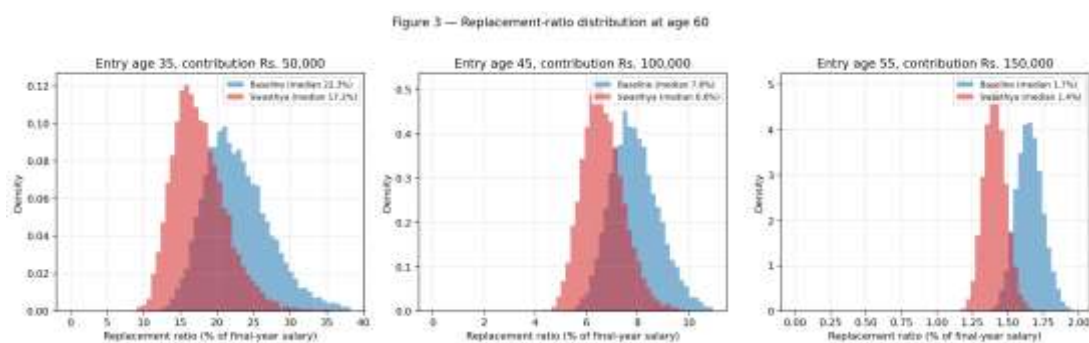


Figure 3 — Distribution of annuity-based replacement ratio at age 60 (% of final-year salary), baseline NPS vs Swasthya (50% take-up), by archetype.

The 100% premature-exit mechanism is rarely triggered when the bundled insurance cover is set at a level comparable to the PMJAY family floater of five lakh rupees: the heatmap across age-at-entry and take-up scenarios records exit probabilities that remain well below one-quarter of one % in every cell, even at the highest behavioral take-up parameter we test. This is consistent with the basic actuarial intuition that an in-network insurance cover of five lakh rupees absorbs nearly the entire severity distribution observed in PMJAY claim data, leaving only the deep tail to interact with the partial-withdrawal cap.

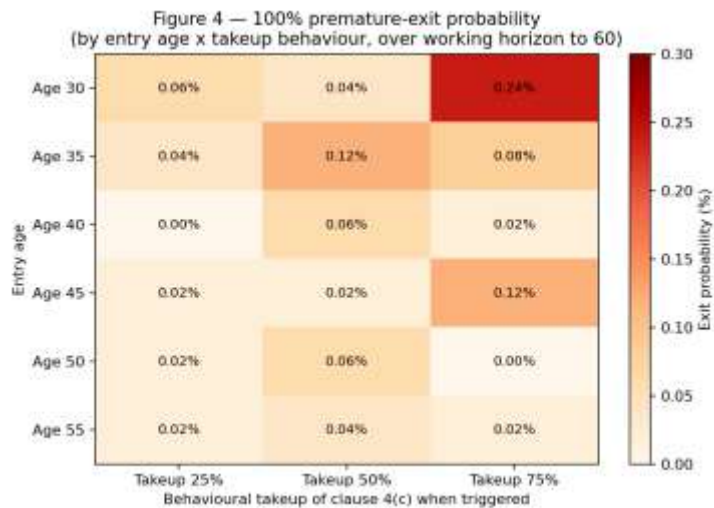


Figure 4 — 100% premature-exit probability across (entry-age × behavioral take-up) cells; the maximum across all cells remains below one-quarter of one %.

Tornado sensitivity confirms which levers actually matter. Equity return and the Swasthya premium level dominate the corpus-erosion picture, with hospitalization rate and severity median entering only as second-order drivers. The practical implication for regulatory calibration is that the premium-indexation rule is the most consequential lever on replacement-ratio adequacy. The premium-cap binding window chart situates this finding inside the year-one ceiling wherein for an entrant at age thirty-five contributing the minimum of twenty-five thousand rupees, the actuarial premium of approximately six thousand rupees fits within the ceiling immediately and remains so as contributions accumulate. However, for an entrant at age fifty-five contributing the same minimum, the actuarial premium of approximately twenty-two thousand rupees is bound by the ceiling for several years before sufficient own-contribution headroom is built. A standardized premium ladder, capped as a percentage of contribution rather than as an age-banded rupee amount, would discipline the drag channel without compromising coverage breadth and would also internalize the cap-binding mechanic into the pricing rule itself.

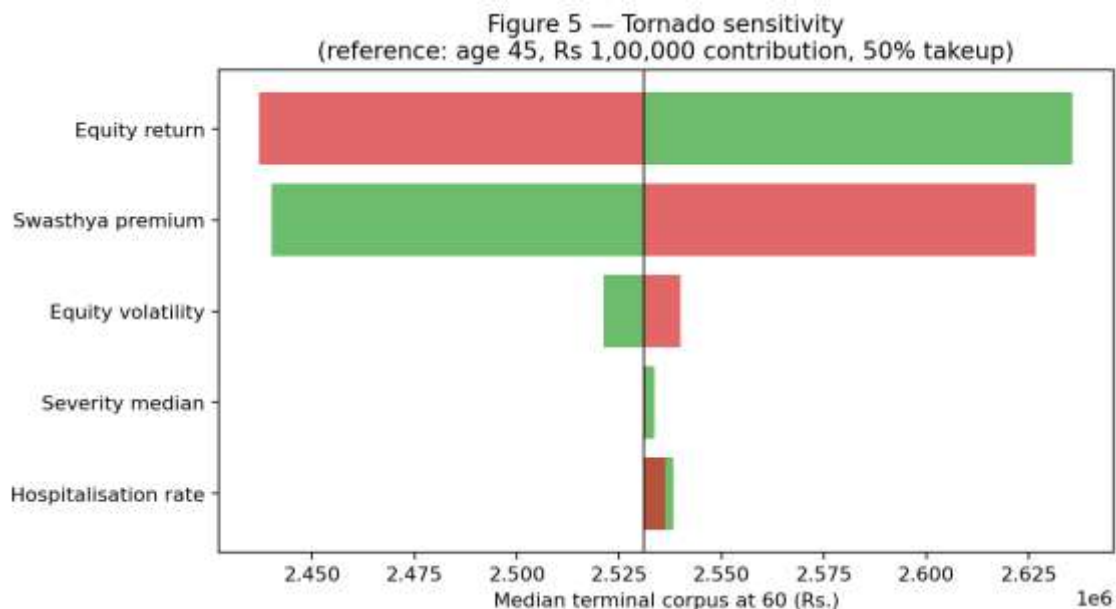


Figure 5 — Tornado sensitivity of median terminal corpus to five drivers (reference: age 45, Rs. 1,00,000 contribution, 50% take-up).

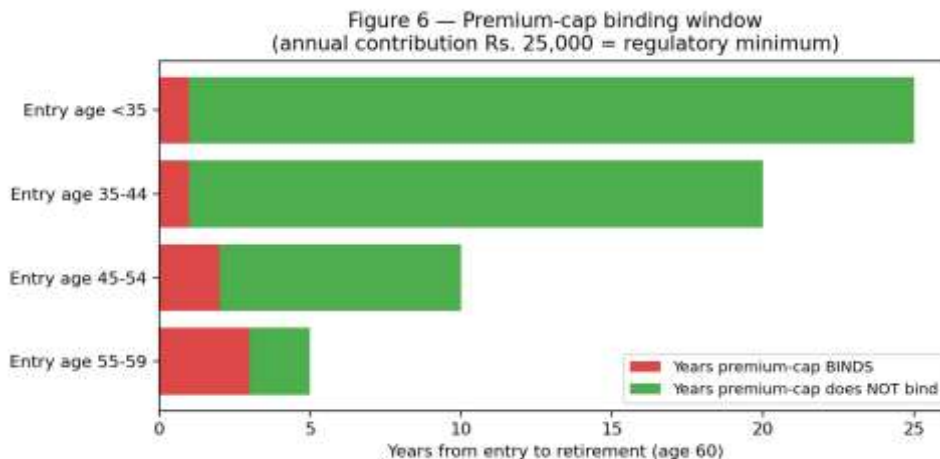


Figure 6 — Premium-cap binding window for an entrant contributing the regulatory minimum (Rs. 25,000 / year): the 25% partial-withdrawal cap binds for 0–3 of the working years depending on entry age band.

7.3 Permissioned-DLT Deployment Architecture

Beyond the data-exchange layer addressed by extant claim-routing infrastructure, a distinct question persists at the supervisory and reconciliation layer which is how should the states of four separate institutional ledgers that comprise of the CRA's units register, the Pension Fund's NAV record, the insurer's policy and claims book and the health administrator's transaction log combined, be reconciled under PoC-2 clause 4(c) when a single inpatient event triggers a cross-system cascade within a matter of hours? A permissioned distributed-ledger technology layer is one candidate architecture. We treat it here as an option available at the graduation phase which may be deliberated.

The design we analyses is a Hyperledger Fabric-style consortium network with PFRDA and participating Pension Funds, Central Recordkeeping Agencies, Health Benefit Administrators and insurers as member nodes (Androulaki et al., 2018). Patient-level data never sits on-chain but the commitment hashes, policy and claim identifiers, partial-withdrawal instructions and clause 4(c) remittance events are the only committed payloads, with off-chain storage holding the underlying records. The architecture is close in spirit to Auer's (2019) proposal for "embedded supervision" in decentralized finance wherein the regulators obtain cryptographically verifiable visibility into a shared state without each having to operate a duplicate reconciliation stack.

On the positive side, four concrete benefits emerge. First, the direct-remittance requirement of clause 4(c) benefits from tamper-evident event ordering wherein if the remittance, the corresponding invoice and the underlying claim are committed as a transaction, audit disputes after the fact become structurally rare. Second, consent artefacts under the Digital Personal Data Protection Act, 2023 can be anchored to the ledger with cryptographic proofs that survive subscriber revocation without leaking the underlying purpose. Third, cross-regulator reconciliation of a sandbox cohort's experience which is essential for full graduation, becomes a query rather than a months-long audit exercise (Monetary Authority of Singapore, 2020).

The countervailing costs are equally material. Throughput ceilings are real wherein empirical benchmarks at the time placed permissioned Fabric-type networks at roughly a thousand to several thousand transactions per second (Dinh et al., 2017), with later optimizations approaching twenty thousand transactions per second under favorable conditions (Gorenflo et al., 2020). Governance overheads which include node admission, key rotation, smart-contract upgrade and dispute resolution among regulators who are peers rather than principals, creates a non-trivial steady-state operating cost that a centralized reconciliation database would not incur. Data-protection compliance deserves the closest attention wherein the Digital Personal Data Protection Act's data-principal rights, including erasure, need to be reconciled with the immutability that makes the technology attractive in the first place. The European Parliament's STOA study identifies off-chain storage as the principal mitigation when personal data remain off-chain and on-chain payloads are restricted to hashes, pointers, or irrevocable claims-processing events, a design discipline that must be coded in from day one if it is to be deployed (Finck, 2019). The operational risk of introducing a new technology layer during a twelve-month sandbox window is itself a policy cost; the technology is mature enough for production use in adjacent domains, but each new consortium is an institutional project.

Two domestic precedents anchor the design. NITI Aayog's Blockchain: The India Strategy, Part I (2020) identifies health records and benefit disbursement as priority use cases for permissioned ledgers and recommends a consortium-led, regulator-observed model. RBI's wholesale digital-rupee pilot, operating

on a permissioned ledger with commercial banks as nodes and the central bank as issuer, confirms that Indian financial regulators have already accepted permissioned DLT as a supervised settlement substrate (Reserve Bank of India, 2022).

The Sandbox cohort should run on conventional application-layer integration with the extant claim-routing infrastructure, with a parallel "observer-only" ledger operated by PFRDA to benchmark the supervisory-read use case. At full graduation, if the supervisory benefit is demonstrated and the DPDP-Act design discipline is honored, the observer layer may be promoted to an active commitment layer for the KPI-bearing events only which comprises of claims-experience, exits, grievance closures. The technology should be instrumented as a graduation tool, not a sandbox prerequisite.

8. Findings and Policy Recommendations

8.1 Findings

NPS Swasthya is the largest product experiment yet undertaken by PFRDA and its trajectory will shape the sandbox practice. The analysis offers four findings.

The scheme is actuarially coherent as a bundled longevity-plus-morbidity product but not neutral with respect to replacement-ratio adequacy: the mandatory-premium channel exerts a measurable, age-dependent drag on the order of fourteen to 22% at the median terminal corpus, with the greatest proportional impact on the youngest, lowest-contribution archetype. The corollary is that the scheme is regressive in its accumulation effect even though it is progressive in its insurance-cover provision.

The dual-account architecture mandated by PoC-1 and reinforced by PoC-2 clause 4(c)'s direct-remittance and excess-transfer rules, creates an asymmetric flow topology: the Swasthya account is a closed loop while the subscriber participates, but every termination event channels surviving corpus into the Common Scheme Account. The architecture interacts with the standard partial-withdrawal cap to produce a year-one regulatory ceiling on premium deduction equal to 25% of own contributions, or six thousand two hundred and fifty rupees for an entrant at the minimum threshold. The actuarial premium ladder used in our model exceeds this ceiling for entrants aged thirty-five and above, indicating that the scheme as currently specified relies on subscribers contributing materially more than the minimum to make the implicit pricing schedule operable.

The 100% premature-exit mechanism is a low-probability event under realistic insurance-cover assumptions; the prudential case rests on the signaling value of direct remittance rather than on its volume. PoC-2 nevertheless materially loosened the trigger that authorizes that exit, replacing PoC-1's seventy-per-cent-of-corpus threshold with a much smaller twenty-five-per-cent-of-own-contributions threshold. The door has been widened even though the volume passing through it is expected to remain modest. Once triggered, the event is binary wherein the subscriber transitions out of Swasthya entirely and cannot, under the present regulatory text, re-enter without a fresh onboarding pathway being created wherein a mechanism needs to be evaluated for the subscriber to re-enter the NPS Swasthya framework during the graduation from a sandbox to scale. A permissioned-ledger supervisory layer is optional at the sandbox stage but attractive at graduation if reconciliation benefits outweigh the governance and data-protection costs.

8.2 Recommendations

Three recommendations follow directly from these findings.

Recommendation 1 — Re-specify the premium-deduction rule as a percentage cap

The deduction taken from a Swasthya account in any contribution year should be defined as the lesser of an actuarial age-banded ladder and 25% of cumulative own contributions, which is the partial-withdrawal headroom the Exits and Withdrawals Regulations already permit. Specifying the deduction in this form internalizes the year-one binding ceiling discussed in Section 4 and Section 7.2, prevents an inadvertent breach of the partial-withdrawal regulation in early years and converts the actuarial ladder from a price the regulator hopes to collect into a price the regulator can supervise against an explicit budget constraint. Drag is disciplined without compromising coverage breadth and the premium-indexation lever which our tornado analysis identifies as second only to equity return in shaping replacement-ratio outcomes, becomes a parametric object that the Authority can recalibrate cohort-by-cohort.

Recommendation 2 — Introduce an annual contribution floor of twenty-five thousand rupees to maintain Swasthya eligibility

The PoC-2 circular fixes the initial onboarding contribution at twenty-five thousand rupees but is silent on the contribution profile required to remain eligible thereafter. We recommend that, at full implementation, an annual contribution floor of twenty-five thousand rupees be specified as the eligibility-maintenance threshold. The rationale is mechanical rather than fiscal wherein the partial-withdrawal cap that funds the next year's premium deduction is a function of cumulative own contributions and a sub-floor contribution year compresses the available headroom and makes the binding-ceiling problem chronic rather than transient. The floor size is also calibrated against measured

medical-cost scales. The NSS 80th Round records a median household out-of-pocket expenditure per hospitalization case of ₹11,285 across all institutional categories and ₹24,000 for private-hospital cases, against a public-hospital median of ₹1,100 (MoSPI/NSO, 2025; PIB, 2026). An annual contribution of twenty-five thousand rupees sustains a 25-per-cent partial-withdrawal headroom of ₹6,250 each year which is enough to fund the lower-bound actuarial premium for an under-thirty-five entrant and to cover roughly the full public-hospital median episode through the partial-withdrawal mechanic, with cases above that scope routing through the clause 4(c) corridor. The floor is operationally familiar wherein it mirrors the auto-debit discipline the APY has used to maintain contribution regularity in informal-sector households and it can be enforced through standard NPS contribution-monitoring infrastructure without statutory amendment. Subscribers who fail to meet the floor would not be expelled but would be moved to an inactive status that pauses Swasthya cover and the corresponding premium deduction until contributions resume.

Recommendation 3 — Open a re-entry pathway after a clause 4(c) catastrophic exit

Under the architecture, a subscriber who has triggered the one-hundred-per-cent premature exit retains a Common Scheme Account balance but cannot return to Swasthya. We recommend that full implementation include a re-entry option for subscribers who exited under clause 4(c), conditional on (i) a maximum look-back window of three contribution years, (ii) a catch-up payment equal to the cumulative annual floor under Recommendation 2 less any contributions made to the Common Scheme Account in the interim and (iii) a fresh consent artefact and a refreshed health declaration to support actuarial pricing. The break-even chart for re-entry shows that, for entrants at the age-thirty-five and age-forty-five archetypes, a three-year catch-up payment is recovered in present-value terms by the resumption of insurance cover within the subsequent five contribution years, even under conservative claims-incidence assumptions; the case is weaker for the age-fifty-five archetype, for which a tighter look-back window would be appropriate. The recommendation is conservative as it does not waive the partial-withdrawal cap, it does not retroactively reverse the original direct remittance and it does not require new technology, but it removes the binary, terminal character of the present exit rule and treats the catastrophic-medical-expense event as a temporary interruption of pension accumulation rather than a permanent expulsion from health-linked pension coverage.

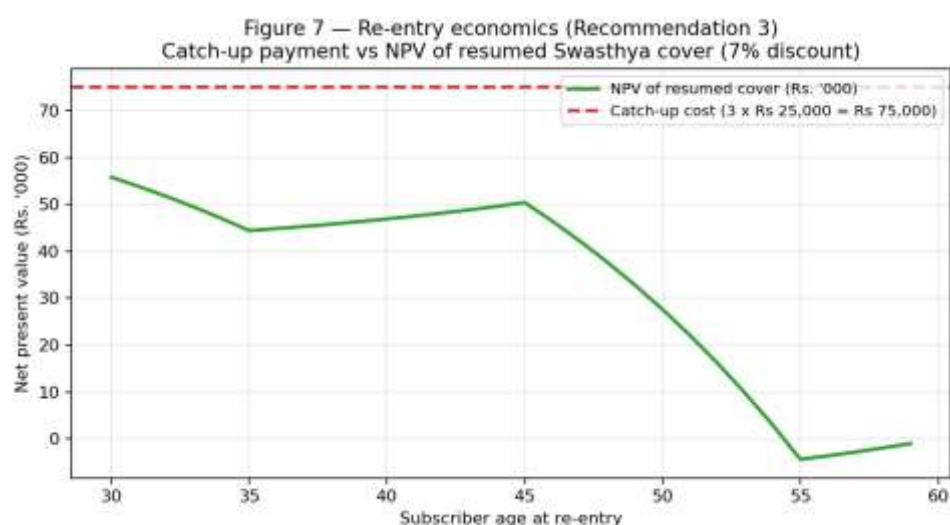


Figure 7 — Re-entry economics under Recommendation 3: NPV of resumed Swasthya cover compared with the Rs. 75,000 catch-up payment (3 × annual floor). Source: authors' calculation, 7% discount rate.

8.3 Limitations

Three limitations of the framework should be acknowledged. First, the model treats severity as the gross episode cost (pre-insurance) and OOP as the residual after a flat ₹5-lakh insurance cover, while NSS 80th Round measures household OOP after all insurance reimbursement; the comparison made in Section 7.1 is order-of-magnitude rather than 1:1 and a more granular model would couple insurance-attachment depth to the institutional-mix question (public vs charitable vs private). Second, the model considers at most one inpatient episode per subscriber per year; subscribers with multiple admissions are treated as a single high-severity event and the partial-withdrawal cap is recomputed against cumulative own contributions, which understates corpus drag for a small minority of high-frequency users. Third, the behavioral lapse parameter is calibrated as a take-up sweep across 25, 50 and 75 % rather than as a structural preference function; revealed-preference data on Indian subscribers' propensity to invoke a 100-per-cent corpus exit under inpatient stress is not yet available and the sweep approach is the honest proxy.

8.4 Way Forward

The permissioned-ledger optionality forms the governance perimeter within which these scheme-design recommendations should be tested. The scheme deserves a level of evidentiary discipline because it is a unique Indian pension policy which has tried to handle retirement and health as a single household problem and the first attempt is the one that sets the template towards the goal of a secured pensioned society.

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