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When Formalization Costs More Than It Pays: Threshold Accrual and the Actuarial Price of Extending Pension Coverage in Morocco

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Abstract

Bringing informal wage earners into contributory pension schemes is expected both to protect workers and to consolidate pay-as-you-go finances. This article tests the second expectation for the long-term branch of Morocco's National Social Security Fund (CNSS), which pays 50% of the reference wage after 3,240 declared days and, since Law 02-24 of 2025, a proportional pension from 1,320 days. It derives the return implied by the legal accrual formula and simulates formalization with a deterministic cohort actuarial model (base 2024, horizon 2070) calibrated on the branch's 2020–2024 accounts. A dirham of wage-indexed contributions purchases an annual pension of 40.5% between 1,320 and 3,240 days, 19.6% after 30 years and 15.5% after 38 years, that is, 3.4 to 8.9 times a self-financing benchmark of 4.6%. Raising the contributing share of private wage employees by one point a year postpones reserve exhaustion from 2036 to 2038 but deepens the 2070 technical deficit from 0.94% to 1.14% of GDP; across six assumed entrant profiles, newly declared workers fund at most 42% of the rights they accumulate by 2070. Under a self-financing linear accrual rule, the long-run effect becomes neutral to slightly positive. Lowering the density on which rights accrue from 293 to 222 days leaves finances almost unchanged but moves 7 to 15 percentage points of a full-career cohort from the full-rate to the reduced pension. Formalization exposes, rather than creates, an accrual mispricing; it should be accompanied by prospective accrual reform and explicit, budgeted support for low earners.

Keywords: pension coverage extension; informal employment; accrual design; pay-as-you-go sustainability; contribution density; Morocco

1. Introduction

Social protection strategies in middle-income countries increasingly treat the extension of contributory pensions to informal workers as a priority (Guven et al., 2021; International Labour Organization [ILO], 2024). Two justifications are advanced together: extension gives workers an entitlement of their own, and each new contributor enlarges a contributory base that ageing erodes. The protective argument is well documented. The financing argument is rarely examined, although it rests on a parameter that policy debates seldom state: the price at which a scheme sells pension rights to the workers it admits. Morocco provides a clear case for measuring that price. Framework Law 09-21 (Kingdom of Morocco, 2021) turned the extension of pension coverage into a legal objective, and the CNSS long-term branch, which insures private-sector wage earners, is the main route through which informal employees can accumulate rights. In 2024 the branch had 4.05 million contributors and 0.84 million

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pensioners and survivors; it collected MAD 19.3 billion in contributions and paid MAD 16.9 billion in benefits (Autorité de Contrôle des Assurances et de la Prévoyance Sociale [ACAPS], 2026). About 70% of private-sector wage employees contributed, which left roughly 1.7 million outside the scheme, and declared employees were reported for an average of 222 days in 2025, or 71% of a full contributory year of 312 days (Caisse Nationale de Sécurité Sociale [CNSS], 2026a). In 2025, Law 02-24 and Decree 2-25-265 (Kingdom of Morocco, 2025a, 2025b) reduced the number of declared days required for a pension from 3,240 to 1,320. Access has widened while benefits already grow faster than contributions.

Two research traditions bear on the problem. Studies of informality separate an extensive margin, made of firms that remain unregistered, from an intensive margin, made of registered firms that under-declare workers or days, and they show how enforcement and the perceived value of benefits shape both (Ulyssea, 2018, 2020; Kumler et al., 2020). Pension design shifts workers between formal and informal jobs (Joubert, 2015), and protection available without contributions can lower formal participation (Bosch & Campos-Vazquez, 2014; Bergolo & Cruces, 2021). Pension-finance theory establishes that a pay-as-you-go scheme can durably pay only the growth of its contributory base, and that promises beyond it accumulate as implicit debt (Samuelson, 1958; Aaron, 1966; Settergren & Mikula, 2005). Evidence from Latin America adds that minimum contribution requirements, combined with intermittent careers, exclude many low-income workers and tilt defined-benefit subsidies towards higher earners (Bucheli et al., 2010; Forteza et al., 2009; Altamirano et al., 2025).

These traditions leave open how the pricing of accrual shapes the financial consequences of formalization. Formalization is usually analysed as a behaviour to induce or a coverage gain to count, rarely as an event that creates liabilities whose value depends on the accrual rule applied to new contributors. For Morocco, existing work associates the deterioration of pension balances with informal employment and demographic ratios (Outlioua & Fazouane, 2023), and earlier simulations of incentives for informal workers produced mixed results without valuing the rights generated (Ennaciri & Yahyaoui, 2025a). No published study appears to have measured the return built into the CNSS formula after Law 02-24, or compared the rights acquired by newly declared workers with the contributions they pay. The article therefore asks whether extending contributory coverage to informal wage earners strengthens or weakens the finances of a threshold-based defined-benefit scheme, and which design feature determines the answer.

Its objectives are to measure the pension a declared day buys, to estimate the short- and long-run financial effects of formalization and their dependence on the accrual rule, and to separate the influence of declaration density on finances from its influence on entitlements. The article makes three contributions. It derives a closed-form schedule of average and marginal accrual returns showing that no eligible career is priced at the self-financing return. It treats formalization as an intertemporal transfer, a liquidity gain followed by a deferred liability, and uses rights-based cohort funding ratios to show that the accrual rule, not formalization, sets the sign of the long-run effect. It shows that the gap between a revenue-consistent density of 293 days and the administrative figure of 222 days matters far more for entitlements than for finances. Earlier studies of the Moroccan system by Ennaciri and Yahyaoui used a dynamic microsimulation model to compare multi-pillar options (2025a) and a qualitative design on family firms (2025b); the present analysis relies on a different model, data and question. Section 2 sets out the framework and propositions, Section 3 the methodology, Section 4 the results and discussion, and Section 5 concludes.

2. Theoretical Framework and Propositions

2.1 What a pay-as-you-go promise can sustainably return

A pay-as-you-go transfer repeated across overlapping generations yields each generation a return equal to the growth of the economy that finances it (Samuelson, 1958), and outperforms saving when the contributory wage bill grows faster than the interest rate (Aaron, 1966). For a steady-state scheme, the internal rate of return equals contribution growth adjusted for changes in the time a unit of contribution stays in the scheme (Settergren & Mikula, 2005). A formula that promises more than this return creates no immediate deficit but an obligation that surfaces when the cohort retires.

Lindbeck and Persson (2003) distinguish the actuarial dimension of a pension system, the strength of the marginal link between contributions and benefits, from its degree of funding. The financial result of extending coverage depends on the first: when new contributors acquire rights for less than they cost, extension improves the short run and burdens the long run, whatever the reserves.

2.2 Accrual design, the contributory wedge and declaration

A contribution acts as a tax only in so far as it fails to buy a valued benefit. Under thresholds and caps, the value of an additional declared day is nil below the eligibility threshold, high close to it and nil again once the cap binds. Because declaration is a joint employer–employee decision, a close benefit–earnings link gives employees a reason to oppose under-reporting. After the Mexican reform of 1997 strengthened that link, wage under-reporting declined most among workers whose benefits became most sensitive to reported earnings (Kumler et al., 2020). In the opposite direction, protection obtained without contributions reduces the value of formal registration (Bosch & Campos-Vazquez, 2014; Bergolo & Cruces, 2021). Instruments aimed at the intensive margin, such as inspection of registered firms, work differently from those aimed at the extensive margin (Ulyssea, 2020); under-declaration of days, the margin at stake for the CNSS, belongs to the former.

2.3 Thresholds, contribution density and access

Because eligibility rules apply to individual careers while accounts record averages, the distribution of contribution density governs access. Using Uruguayan work histories, Bucheli et al. (2010) find that most contributors are at risk of not meeting the minimum years required for an ordinary pension. Altamirano et al. (2025) show that, once minimum contribution requirements are applied to observed careers, defined-benefit subsidies in several Latin American countries accrue mainly to the upper income deciles. Reconstructing work histories in Chile and Uruguay, Forteza et al. (2009) find that many workers would not qualify for a basic pension at 65 if eligibility rules were strictly enforced. A linear accrual rule, under which every declared day buys the same pension, removes thresholds altogether; points and notional-account schemes apply this principle, with the point yield playing the role of the accrual rate (Holzmann et al., 2020). Such rules are actuarially neutral only when their yield equals the sustainable return and a balancing mechanism keeps them solvent (Valdés-Prieto, 2000), and their distributive fairness depends on the annuity divisor chosen (Boado-Penas et al., 2022).

2.4 Propositions

Four propositions follow. They are confronted with the legal formula and model simulations rather than tested statistically, and each states an outcome that would contradict it.

P1 (pricing). Under the CNSS formula, the pension purchased by a dirham of contributions exceeds the self-financing return for every eligible career length, and the excess is greatest for short careers. P1 would be rejected if any eligible career length earned a return at or below the benchmark.

P2 (intertemporal mismatch). Under current rules, formalizing informal wage earners improves the branch's cash position in the short run and deepens its long-run deficit. P2 would be rejected if formalization improved the 2070 technical balance.

P3 (design dependence). The accrual rule, not formalization itself, determines the sign of the long-run effect: under a self-financing linear rule, formalization no longer worsens the long-run balance. P3 would be rejected if formalization still deepened the 2070 deficit under that rule.

P4 (asymmetry). Declaration density affects individual entitlements far more than scheme finances. P4 would be rejected if moving the entitlement density from its upper to its lower bound shifted the reserve-exhaustion year by more than two years while leaving entitlements broadly unchanged.

P2 and its counter-result, which motivates P3, were specified before the simulations; P1 and P4 organize the rule analysis and a density variant and are not pre-registered hypotheses.

3. Methodology

3.1 Research design and institutional setting

The design is deductive and quantitative: an analytical evaluation of the legal accrual formula and conditional simulations from a deterministic cohort actuarial model. No behavioural response is estimated; formalization paths and entrant characteristics are imposed, so results describe the actuarial consequences of the rules, not forecasts.

The CNSS long-term branch levies 11.89% (3.96% on employees, 7.93% on employers) on monthly wages capped at MAD 6,000, a ceiling unchanged since 2002. For an insured person with D declared days and a reference wage $\hat{W}$, defined as the average capped wage of the last 96 months, the annual old-age pension as a share of $\hat{W}$ is

$$p(D) = \begin{cases} 0, & D < 1{,}320 \\ 0.50\dfrac{D}{3{,}240}, & 1{,}320 \le D < 3{,}240 \\ \min\left(0.70,\ 0.50 + 0.01\left\lfloor\dfrac{D - 3{,}240}{216}\right\rfloor\right), & D \ge 3{,}240 \end{cases} \quad (1)$$

Insured persons with fewer than 1,320 days receive a refund of their contributions without interest. Reduced pensions carry floors of MAD 600 to 1,000 and full-rate pensions a minimum of MAD 1,000. No legal rule provides automatic indexation of pensions in payment, the ceiling or the minimum pensions.

3.2 Accrual-return analysis

Counting 312 declared days as one year and expressing contributions in units of the reference wage, a career of D days generates wage-indexed contributions of :

$$c(D) = \tau \frac{D}{312}, \qquad \tau = 0.1189. \tag{2}$$

The average return is the annual pension purchased per unit of contributions; the marginal return is the pension added by one more declared year divided by its contribution:

$$y(D) = \frac{p(D)}{c(D)}, \qquad y_m(D) = \frac{312}{\tau}\frac{\Delta p(D)}{\Delta D}. \tag{3}$$

Both are compared with a self-financing benchmark y^* and the corresponding linear accrual rate α^*:

$$y^* = \frac{1}{\ddot{a}_{65}} = \frac{1}{21.9} = 4.6\%, \qquad \alpha^* = \tau y^* = 0.54\% \text{ per year.} \tag{4}$$

The annuity factor $\ddot{a}_{65}$ is the expected number of years of wage-indexed pension payments from age 65, valued with the model's 2050 period life table, that is, the United Nations (2024) medium-variant rates scaled to the official life expectancies (Section 3.3). Survivor benefits enter as a reversionary annuity: 60% of pensioners' deaths leave an eligible spouse, five years younger, who then receives half the pension for life. At y^*, a cohort's pensions roughly equal its contributions when both are revalued with average earnings (Aaron, 1966); $m(D) = y(D)/y^*$ measures the mispricing.

The benchmark is a reference point, not a replica of the CNSS. CNSS pensions start at 60, which lowers the self-financing return, but are not revalued, which raises it. Section 4.1 therefore also reports the number of wage-indexed benefit years at which the formula just finances itself, a measure free of annuity assumptions. Two conventions make the computed returns conservative. The whole 11.89% rate is attributed to old-age pensions, although the branch also pays invalidity and survivor benefits: survivors account for 29% of its pensioners and about 17% of pension spending, and invalidity pensions for under 1% of both (CNSS, 2026b; spending estimated at bracket midpoints). Because y^* includes a survivor's pension and $p(D)$ does not, any allocation below 100% raises $m(D)$ in proportion. Minimum-pension floors are also ignored.

3.3 The cohort actuarial projection model

Scheme-level effects are simulated with the Moroccan Pension Projection Model (MPPM), a deterministic cohort actuarial model built on the approach of social security actuarial valuations (Plamondon et al., 2002). Cells are defined by single year of age (0–100), sex, seven labour-market groups and twenty earnings nodes of a log-normal distribution. For the CNSS, each cell records insured persons, mean declared days, revalued past earnings and contributions paid. Since thresholds apply to individuals, declared days within a cell follow a gamma distribution with the cell mean and a coefficient of variation of 0.5, evaluated at 40 points, and the 1,320- and 3,240-day thresholds are applied point by point.

Demography follows the central variant of the official 2024–2060 projection based on the 2024 census (Haut-Commissariat au Plan [HCP], 2026): life expectancy at birth reaches 79.7 years for men and 83.8 for women in 2060, fertility falls from 1.97 to 1.81 and net migration reaches zero in 2050. Single-age mortality rates are the United Nations (2024) medium variant

scaled to the official life expectancies. The years 2061–2070 extend the projection by the cohort-component method with the official 2060 assumptions held constant (2060 mortality, fertility of 1.81 with the United Nations age schedule, zero net migration), giving 43.7 million inhabitants in 2070, 28.2% of them aged 60 or over; an alternative extension based on the United Nations projection moves the 2070 system balance by about 0.1 percentage point of GDP. The horizon truncates the retirement of the large cohorts born around 2010, which the rights-based valuation of Section 3.4 partly offsets. Prices rise by 2% and real wages by 1.5% a year.

Contributions in year t sum over cells (a, s, q):

$$C_t = \sum_{a,s,q} \tau \min\left(w_{a,s,q,t}, \overline{P}\right) \times 12 \times \delta \times K_{a,s,q,t}\,, \tag{5}$$

where w is the monthly wage of the cell, $\bar{P}$ the ceiling, K the number of contributors and δ the share of the year for which contributions are declared. Reserves follow

$$F_t = F_{t-1}(1 + r) + C_t - B_t, \tag{6}$$

with B_t the benefits paid and r the net yield on reserves. The value $r = -1.61\%$ is not an investment return but the average yield implied by the branch's accounts over 2015–2018 and 2023–2024, the years with consistent published reserves and flows:

$$r = \frac{F_t - F_{t-1} - C_t + B_t}{F_{t-1}} = y - \frac{A_t + T_t}{F_{t-1}}, \tag{7}$$

where y is the gross return on the reserves deposited with the Caisse de Dépôt et de Gestion, A_t the management costs charged to the branch and T_t its net transfers to the family-allowance and short-term branches, neither of which the published accounts itemize. With a gross return of 4%, these outflows equal about 5.6% of reserves, or MAD 3.7 billion a year. The reference keeps the net yield, since crediting the gross return would postpone exhaustion for accounting reasons; a variant applies 4%.

The revenue density is identified from the 2024 accounts:

$$\delta = \frac{19.3}{0.1189 \times 12 \times 3{,}564 \times 4{,}045{,}862 \times 10^{-9}} = 0.938 \qquad \text{(293 days)}, \tag{8}$$

where MAD 3,564 is the modelled mean capped wage. With the published wage distribution, 222 days per declared employee would yield only about MAD 14.6 billion, a quarter less than recorded. The revenue identity weights days by the capped wage, whereas eligibility counts days per person, so the two figures describe different moments of one distribution, and the density on which rights accrue is bounded by

$$0.712 = \frac{222}{312} \le \delta_{acc} \le \delta = 0.938. \tag{9}$$

The career parameter, defined as the share of years since age 22 with declared contributions, is set at 0.50 by least squares on published pensioners and benefits for 2020, 2022, 2023 and 2024 (the 2021 accounts do not report the branch separately). Modelled pensioners differ from the accounts by 1.8% to 5.3% and benefits by −1.5% to −11.3%, the largest gap matching an apparent break in the 2022 benefit series. This is a calibration, not an independent validation:

chosen on 2020 and 2022 alone, the parameter overestimates 2023 and 2024 pensioners by 9.5% and 11.5%, so Section 4.5 reports results across its identification range (0.45–0.77).

3.4 Scenarios, indexation and valuation

The reference projection (S0) applies the 2026 rules, including the absence of any revaluation of CNSS pensions in payment, of the MAD 6,000 ceiling and of minimum pensions; pensions in payment thus lose about 3.5% a year relative to average wages. Because minima have been raised occasionally (from MAD 600 to 1,000 in 2011) while the ceiling has been fixed since 2002, S0 is an upper bound of this erosion. An indexed reference (S0i) links the ceiling and minimum pensions, including the Law 02-24 floors, to the average wage from 2025; pensions in payment stay unrevalued in both. Occasional discretionary increases are not extrapolated; any future increase in pensions in payment would raise expenditure, so both references understate cost in this respect.

The formalization scenario (S3c) raises the share of private-sector wage employees contributing to the CNSS from 70.4% in 2024 by one percentage point a year until it reaches 90% in 2044; variants use 0.5 and 2 points a year. Entrants have no prior rights and, in the central profile, the wages, density and ages of current contributors. Five alternative profiles set their mean wage at the 2024 minimum wage (MAD 3,111 a month), set entitlement density at 222 days, restrict entry to ages 35–59, delay formalization to 2030, or combine the first three.

The linear-accrual counterfactual applies $p = \alpha^{*}D/312$ to days declared from 2025, on capped wages revalued with average earnings. Rights acquired before 2025 keep the current formula, including the minimum pension and the Law 02-24 pension; post-2025 days carry no minimum pension, and careers that stay below 1,320 days are valued at the linear rate rather than refunded. The counterfactual isolates the accrual rule and is not a reform proposal: it keeps the frozen ceiling and unrevalued pensions of S0 and assumes no behavioural response. Since α^{*} is calibrated for wage-indexed pensions, the rule is, if anything, cheaper than self-financing within the model; a like-for-like variant uses $\alpha = \tau/\ddot{a}_{60} = 0.708\%$, the self-financing rate for a pension flat in dirhams from age 60, valued at wage growth.

Because the 2070 cash balance omits rights still to be paid, the rights of newly declared workers are valued on a termination basis at the end of 2070, discounted at the growth rate of average earnings ($g = 3.5\%$), and compared with their contributions and benefits through a cohort funding ratio:

$$\varphi = \frac{\sum_{t=2025}^{2070} C_t^{new}(1+g)^{2070-t}}{\sum_{t=2025}^{2070} B_t^{new}(1+g)^{2070-t} + AR_{2070}^{new}}, \tag{10}$$

where AR_{2070}^{new} denotes their accrued rights; a value below one means that contributions do not cover the rights drawn and accumulated. In the density analysis, contributions stay at 293 days while rights accrue at 222 days, read for the projection and for a full-career cohort entering at 22 and retiring at 60.

3.5 Key assumptions and their sensitivity

Table 1 lists the assumptions that most affect the results and where their sensitivity is reported.

Table 1. Key Assumptions, Their Basis and Their Sensitivity

Assumption	Central value	Basis	Sensitivity reported
Demography	Official central variant; extended 2061–2070	HCP (2026)	UN-based extension: ±0.1 pp of GDP in 2070
Mortality	UN medium variant scaled to official life expectancy	United Nations (2024)	Break-even test for the benchmark (Section 4.1)
Net reserve yield	−1.61% a year	Published flows, Eq. (7)	Gross 4% (Tables 3 and 4)
Revaluation	None (S0)	Legal rules	Indexed ceiling and minima, S0i (Section 4.2)
Annuity factor	21.9 years at 65, survivors included	UN rates scaled to HCP, 2050	Break-even benefit years (Section 4.1)
Linear rule	0.54% per declared year from 2025	Eq. (4)	0.708% for unindexed pensions (Table 4)
Days within cells	Gamma, coefficient of variation 0.5	Thresholds apply to individuals	Coefficients of variation 0.3 and 0.7 (Table 6)
Revenue density	293 days	Eq. (8)	Rights at 222 days; refit (Section 4.5)
Career parameter	0.50	Least squares, 2020–2024	Range 0.45–0.77 (Table 6)
Macroeconomy	Prices 2%, real wages 1.5% a year	Long-run assumption	Not varied in this article

Note. pp = percentage points. HCP = Haut-Commissariat au Plan; UN = United Nations.

3.6 Data, evidence status and ethics

All inputs are published statistics: HCP census and survey tabulations, ACAPS accounts for 2019–2024, CNSS publications and legal texts; the 222-day figure is provisional and uncertified. No individual data or human participants were involved, so ethical approval was not required.

4. Results and Discussion

4.1 What a declared day buys

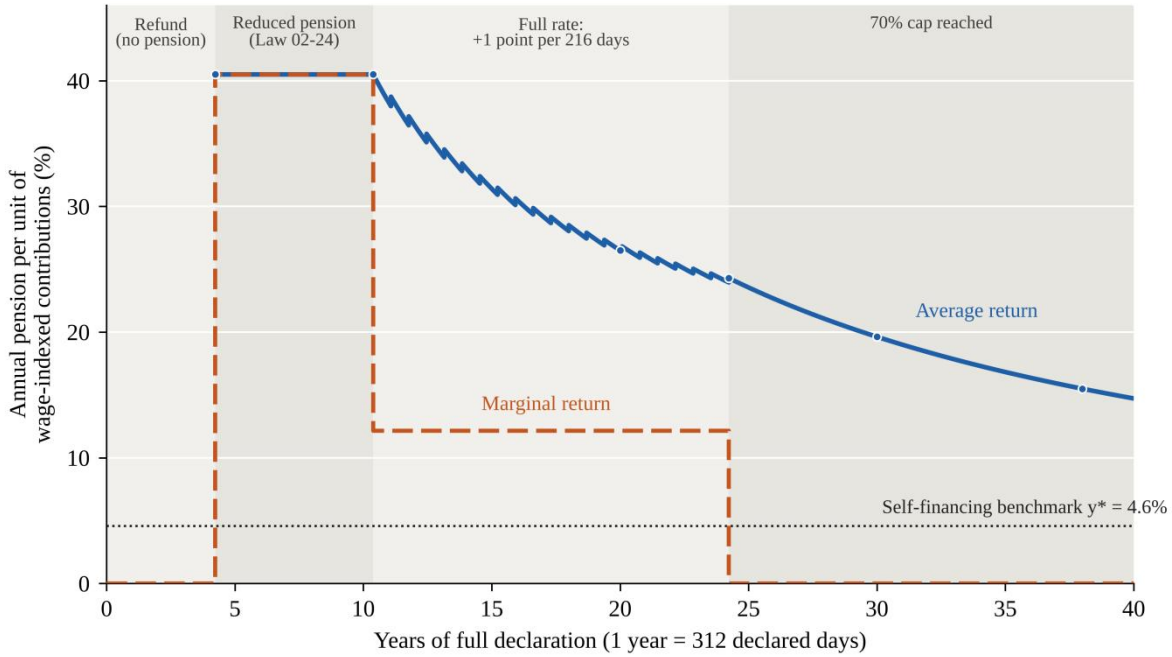
Table 2. Return of the CNSS Old-Age Formula by Declared Career, per Unit of Wage-Indexed Contributions

Declared days	Years of declaration	Pension (% of reference wage)	Average return (%)	Multiple of y^*	Marginal return beyond this point (%)	Break-even benefit years
1,320	4.2	20.4	40.5	8.9	40.5	2.5
3,240	10.4	50.0	40.5	8.9	12.1	2.5
6,240	20.0	63.0	26.5	5.8	12.1	3.8
7,560	24.2	70.0	24.3	5.3	0.0	4.1
9,360	30.0	70.0	19.6	4.3	0.0	5.1
11,856	38.0	70.0	15.5	3.4	0.0	6.5

Note. Computed by the author from Equations (1)–(4); $y^* = 4.6\%$. Contributions at 11.89% of the capped wage; one year = 312 declared days. Break-even benefit years = 1/y(D), the number of wage-indexed pension years that contributions would finance. Minimum-pension floors are not included.

Table 2 and Figure 1 present the accrual-return schedule. Below 1,320 days contributions are refunded in nominal terms, a negative real return; the 1,320th day turns the refund into a pension of 20.4% of the reference wage. Between 1,320 and 3,240 days, the reduced pension created by Law 02-24 is proportional to days at the same rate as the full-rate threshold, so average and marginal returns are both 40.5%, or 8.9 times the benchmark. Beyond the threshold, each block of 216 days adds one point of replacement, a marginal return of 12.1% (2.7 times the benchmark), until the 70% cap is reached after 24.2 years; additional declaration then adds nothing.

Figure 1. Average and Marginal Return of the CNSS Old-Age Formula by Years of Full Declaration



Note. Average return = annual pension divided by wage-indexed contributions, Equation (3); marginal return = pension added by one more declared year divided by its contribution. Markers show the career lengths of Table 2. Shaded bands mark the four segments of Equation (1).

P1 holds without exception: even a 38-year career earns 3.4 times the self-financing return. The mispricing peaks where newly formalized workers are likely to be, in the 1,320–3,240-day band that Law 02-24 opened to careers that used to end in a refund. Incentives are non-monotonic: a declared day has no marginal value below 1,320 days or beyond the cap, where employees have no reason to resist under-declaration (Kumler et al., 2020), and a very high value in between.

P1 does not depend on the annuity factor. The formula would just pay for itself after 2.5 wage-indexed benefit years up to the 3,240-day threshold, 5.1 years after 30 years and 6.5 years after 38 years (Table 2). Any plausible benefit duration from age 60 exceeds these values, even allowing for the erosion of unrevalued pensions, so the result is robust to the mortality, survivor and indexation assumptions behind y^*.

4.2 Formalization: a liquidity gain and a long-run liability

Table 3 reports the branch's response to formalization under current rules. At one point a year, the 2030 technical balance improves from −0.17% to −0.09% of GDP, the first technical

deficit moves from 2027 to 2028 and reserve exhaustion from 2036 to 2038 (2042 with a 4% gross yield). From the 2050s the new contributors retire, and the 2070 deficit reaches 1.14% of GDP instead of 0.94%. Two points a year gain only one more year and deepen the deficit further; with a 4% yield, exhaustion falls between 2041 and 2043 across paces. P2 is supported within the model.

Table 3. CNSS Long-Term Branch Under Alternative Paces of Formalization, Current Rules

Scenario	First technical deficit	Reserve exhaustion (yield −1.61%; 4%)	Contributors, 2050 (thousands)	Pensioners, 2070 (thousands)	Technical balance, 2050 (% of GDP)	Technical balance, 2070 (% of GDP)	Aged 60+ with own pension, 2070 (%)
Reference (S0)	2027	2036; 2039	4,854	3,803	−0.92	−0.94	30
S3c, 0.5 point a year	2028	2037; 2041	5,729	4,347	−0.89	−1.03	34
S3c, 1 point a year	2028	2038; 2042	6,172	4,665	−0.94	−1.14	36
S3c, 2 points a year	2030	2039; 2043	6,172	4,786	−1.02	−1.17	36

Note. GDP of the reference projection. Pensioners include survivors. Gross yield of 4%: unitemized outflows charged outside the branch. Own pension: direct-entitlement pension from a basic scheme, whole population aged 60 and over. Coverage is capped at 90% of private wage employees, a level both the 1- and 2-point paths reach before 2050; hence their identical 2050 contributor counts. Effects quoted in the text are computed from unrounded output and may differ by 0.01 point from differences of the rounded values (1 point a year: −0.19 rather than −0.20 in 2070).

The result does not stem from the erosion of parameters fixed in dirhams. Under the indexed reference S0i, the same formalization postpones exhaustion from 2038 to 2041 but deepens the 2070 deficit by 0.37 percentage point of GDP, compared with 0.19 point under current rules. The frozen ceiling dampens the cost of formalization rather than producing it, because an indexed ceiling promises each new contributor a pension that keeps pace with wages. Against this cost, the share of people aged 60 and over with a pension of their own rises from 30% to 34–36% in 2070, depending on the pace (Table 3).

4.3 Design, not formalization, sets the sign

Table 4 combines the formalization scenario with the two accrual rules. Under the linear rule, the 2070 deficit of the reference projection falls from 0.94% to 0.33% of GDP and the debt accumulated by 2070 from 29.6% to 16.8% of GDP; with formalization, the 2070 deficit is 0.31% instead of 1.14%. Formalization therefore worsens the 2070 balance by 0.19 percentage point under the current formula and improves it by 0.02 point under the linear rule (differences computed from unrounded model output, hence 0.19 rather than the 0.20 implied by Table 3), which supports P3. The cohort funding ratio of Equation (10) agrees: entrants' contributions cover 42% of the pensions paid and promised to them by 2070 under the current formula and 154% under the linear rule, which exceeds one because α^* assumes wage-indexed pensions whereas the projection keeps them unrevalued. The like-for-like variant priced for unindexed pensions ($\alpha = 0.708\%$) removes this asymmetry: entrants then fund 118% of their rights, and formalization changes the 2070 balance by −0.004 point (Table 4). The 0.02-point gain is thus an upper bound, and the robust result is neutrality rather than gain.

Table 4. Formalization and the Accrual Rule: CNSS Long-Term Branch

Scenario and accrual rule	Reserve exhaustion, net yield −1.61%	Reserve exhaustion, gross yield 4%	Technical balance, 2050 (% of GDP)	Technical balance, 2070 (% of GDP)	Debt, 2070, r = g (% of GDP)	New pension / mean wage, 2050 (%)	New pension / mean wage, 2070 (%)
S0, current formula	2036	2039	−0.92	−0.94	29.6	22	13
S0, linear rule	2037	2041	−0.63	−0.33	16.8	13	6
S3c, current formula	2038	2042	−0.94	−1.14	30.4	21	13
S3c, linear rule	2040	2045	−0.48	−0.31	12.2	11	6
S0, linear rule, α = 0.708%	2037	2040	−0.70	−0.47	19.8	15	8
S3c, linear rule, α = 0.708%	2039	2044	−0.57	−0.48	15.7	13	8

The gain costs adequacy. Without the threshold and minimum pension for future days, and with wages still capped at MAD 6,000, the mean new pension falls to 13% of the mean wage in 2050 and 6% in 2070, against 22% and 13%. The linear rule makes formalization affordable, not pensions adequate; adequacy requires an indexed ceiling, indexed pensions and, for low earners, an explicit State contribution.

4.4 Robustness to the profile of new contributors

The wages, density and ages of workers who would be formalized are not observed, so Table 5 projects them as a separate group under six assumed profiles. In every case, formalization postpones exhaustion by one or two years and deepens the 2070 deficit, which ranges from 1.10% to 1.28% of GDP, with the new contributors themselves accounting for 0.16 to 0.33 percentage point. Older entrants cost most: their careers are too short to fund the pensions guaranteed by the minimum pension and Law 02-24.

Table 5. Formalization at One Point a Year Under Six Profiles of Newly Declared Workers

Profile of newly declared workers	Reserve exhaustion	Technical balance, 2050 (% of GDP)	Technical balance, 2070 (% of GDP)	Of which new entrants, 2070 (% of GDP)	Mean new pension, 2050 (MAD/month)	Retiring with refund only (%)	Retiring at full rate (%)
Central: as current contributors	2038	−0.91	−1.14	−0.20	2,554	8	67
Mean wage at minimum wage	2038	−0.91	−1.11	−0.16	2,101	8	67
222 declared days a year	2038	−0.92	−1.13	−0.19	2,282	13	54
Aged 35–59 at entry	2038	−1.00	−1.28	−0.33	2,549	9	62
Formalization from 2030	2037	−0.84	−1.10	−0.16	2,211	10	61
Minimum wage, 222 days, aged 35–59	2037	−0.98	−1.20	−0.26	1,884	15	48

Source: author's cohort actuarial model (MPPM)

The 2070 cash balance understates the cost because most newly declared workers have not retired by that date. Valued on a termination basis, their accrued rights amount to 8.6% of GDP in the central profile and 7.6% to 10.0% in the others. Their contributions cover 42% of the pensions paid and rights held in the central profile and 27% in the least favourable one, and no profile exceeds 42% (Equation 10). Each dirham they contribute thus acquires rights worth roughly 2.4 to 3.7 dirhams.

4.5 Declaration density: rights move, finances do not

Table 6 compares the two density bounds of Equation (9) across the identification range of the career parameter. Allowing rights to accrue on 222 rather than 293 days more than doubles the small share of a full-career cohort that leaves with a refund, raises the share confined to the reduced pension by 7 to 15 percentage points and lowers the share reaching the full rate by 7 to 18 points. The branch's finances barely change: reserves are exhausted in 2036 or 2037, and the 2070 technical balance stays between −0.87% and −0.96% of GDP. Narrower or wider dispersion of declared days (coefficients of variation 0.3 and 0.7) leaves the pattern intact: the full-rate share falls by 17 and 13 points, while the 2070 balance moves by 0.06 to 0.07 point. P4 is supported, with one qualification. When 222 days are applied to contributions as well as rights and the wage distribution is re-estimated, exhaustion moves to 2035 and the 2070 deficit to 1.15% of GDP, but only with a median wage inconsistent with the published one.

Table 6. Entitlement Density and the Career Parameter: Full-Career Cohort and Branch Finances

Career parameter (selection criterion)	Full-rate pension (%)	Reduced pension (%)	Refund only (%)	Reserve exhaustion	Technical balance, 2070 (% of GDP)
0.45 (mean errors, 2020–2024)	73.9 → 55.5	23.9 → 39.2	2.2 → 5.3	2037 → 2037	−0.94 → −0.87
0.50 (least squares; reference)	79.4 → 63.1	19.0 → 33.1	1.6 → 3.8	2036 → 2037	−0.94 → −0.88
0.61 (least squares at 222 days)	87.3 → 75.4	11.8 → 22.6	0.8 → 2.1	2036 → 2036	−0.95 → −0.89
0.77 (out-of-sample choice)	93.3 → 85.8	6.3 → 13.2	0.4 → 1.0	2036 → 2036	−0.96 → −0.90
0.50, coefficient of variation 0.3	94.0 → 77.0	6.0 → 22.9	0.0 → 0.1	2036 → 2036	−1.00 → −0.94
0.50, coefficient of variation 0.7	67.9 → 54.8	24.1 → 32.5	8.0 → 12.7	2037 → 2038	−0.86 → −0.79

Note. Each cell reads "entitlement density of 293 days → 222 days". Shares refer to a cohort entering at 22 and retiring at 60, with declared days distributed as a gamma law with a coefficient of variation of 0.5 unless stated; contributions are kept at 293 days throughout. The 222-day density is a provisional, uncertified CNSS figure (CNSS, 2026a). Dispersion variants keep the career parameter at 0.50 without refitting.

The levels in Table 6 are uncertain by a factor of about two, because aggregate accounts identify mean flows but not the dispersion of careers, which the thresholds make decisive; the direction is robust. A projection applying 222 days to rights alone would present a loss of entitlements as a financial gain.

4.6 Discussion

Table 7. Propositions, Evidence and Verdict

Proposition	Evidence	Verdict
P1 Pricing	Legal formula, Equations (1)–(4); Table 2	Supported for all eligible careers; arithmetic and robust to the benchmark
P2 Intertemporal mismatch	Three paces and six profiles; Tables 3 and 5	Supported in every run; conditional simulation
P3 Design dependence	Linear-accrual counterfactual, two rates; Table 4	Supported (−0.004 to +0.02 point); conditional simulation
P4 Asymmetry	Density bounds × career-parameter grid; Table 6	Supported in direction; levels uncertain by a factor of about two

Note. Source: author

As Table 7 shows, the four propositions hold within the model and point to one mechanism. Formalization under the current formula reproduces, in miniature, the introduction of a pay-as-you-go scheme: new contributors pay for years before drawing, a transitional windfall, while each cohort is promised several times the return the contributory base can sustain, a deferred liability (Samuelson, 1958; Aaron, 1966; Settergren & Mikula, 2005). Exhaustion years and annual balances record the windfall and conceal the liability, which the cohort funding ratio of 27% to 42% reveals. Formalization exposes an accrual mispricing that already applies to current contributors; it does not create it.

These findings qualify the view that bringing informal workers into contributory schemes helps restore their balance (Outlioua & Fazouane, 2023; Guven et al., 2021), and refine earlier simulations that did not value the rights incentives generate (Ennaciri & Yahyaoui, 2025a). Extension remains justified on protection grounds but must be financed as protection. The results are consistent with Altamirano et al. (2025): where Latin American thresholds exclude intermittent careers, Morocco's lower threshold admits them into the most generous segment of the formula, improving access while enlarging the unfunded promise.

The schedule also suggests an untested behavioural channel: zero marginal returns below 1,320 days and beyond the cap remove employees' interest in full declaration, while the high return in between rewards declaring just enough days to cross a threshold. A linear rule would give every day the same value, which Mexican evidence associates with less under-reporting (Kumler et al., 2020). Conversely, AMO Tadamon, the State-financed health insurance granted to households below a score threshold of the Unified Social Registry (Registre social unifié, RSU), may lower the value of contributory affiliation, as observed elsewhere (Bosch & Campos-Vazquez, 2014; Bergolo & Cruces, 2021).

P3 carries the design implication. With acquired rights protected, a prospective linear or points-based rule would stop each new cohort from adding unfunded obligations, without retiring the existing implicit debt (Holzmann et al., 2020; Valdés-Prieto, 2000). Its yield should equal the self-financing return and its annuity divisor be chosen with distributive effects in mind (Boado-Penas et al., 2022); extra generosity for low earners would then appear as an explicit, budgeted State top-up rather than as deficits after 2050.

The results are specific to Moroccan rules and the model's assumptions, but their logic applies to any threshold-based scheme whose accrual rate exceeds the sustainable return: there, extending coverage is a fiscal commitment, not a source of financing.

5. Conclusion

5.1 Principal findings

Under its current formula, extending coverage to informal wage earners weakens the long-run finances of the CNSS long-term branch, and the accrual rule determines this outcome. Over eligible careers of 4.2 to 38 years, the formula returns 3.4 to 8.9 times a self-financing benchmark of 4.6%, with the highest multiples in the short-career band opened by Law 02-24. Formalizing one point of private wage employment a year postpones exhaustion from 2036 to 2038 but deepens the 2070 deficit from 0.94% to 1.14% of GDP, and entrants fund at most 42% of their rights. Under a self-financing linear rule the long-run effect becomes neutral to slightly positive. Declaration density governs entitlements far more than finances.

5.2 Theoretical contributions

The article connects two literatures that are usually discussed separately. It shows that the financial effect of reducing informality on the intensive margin depends on the actuarial link between contributions and benefits, the dimension that Lindbeck and Persson (2003) distinguish from funding, and it makes the Aaron–Samuelson bound operational for a single accrual formula through a closed-form return schedule and a rights-based cohort funding ratio. It also distinguishes revenue density from entitlement density, explaining why aggregate accounts identify finances but not entitlements.

5.3 Practical and managerial implications

Four implications follow. Formalization campaigns should be paired with reform of future accrual, preferably a linear or points-based rule priced at the self-financing yield, with acquired rights preserved. Extra generosity for low earners and short careers should be an explicit, budgeted State contribution. Actuarial reporting should add rights-based indicators, such as the cohort funding ratio of new affiliates, to cash-flow measures. Finally, the CNSS should publish the distribution of declared days per employee and per firm, reconcile its 222-day figure with collected contributions, itemize the costs and transfers charged to the long-term branch’s reserves, and direct inspection towards registered firms whose declared days per employee remain persistently low.

5.4 Limitations and future research

Five limitations apply. The model represents no behaviour, so formalization paths and the profiles of new contributors are assumptions. The CNSS branch is calibrated on four years of published accounts rather than independently validated, and its career parameter and within-cell dispersion of declared days are weakly identified. The share of the 11.89% rate allocated to old-age pensions is not published, and the 222-day figure is provisional. The comparison with the benchmark depends on mortality, survivor and indexation assumptions, although the break-even test does not. Finally, the analysis is partial-equilibrium and stops in 2070, before the large cohorts born around 2010 have fully retired. Future research should use CNSS career records to replace the assumed distribution of declared days, estimate how declaration responds to accrual reform, and embed the cohort model in a general-equilibrium framework. Until the price at which rights are sold matches what contributions can sustain, each success in extending coverage will also enlarge a liability that current accounts do not show.

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