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Nudge Architectures, Default Effects, and Long-Term Pension Enrolment Persistence

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Abstract

Occupational pension savings rates across Europe remain systematically below levels required to sustain pre-retirement living standards for the majority of workers, generating projected retirement income adequacy deficits that will intensify as demographic ageing erodes pay-as-you-go public pension systems. Behavioural economics offers a toolkit of low-cost nudge interventions — default enrolment, social norm messaging, loss and gain framing, and combined nudge architectures — that have demonstrated substantial enrolment effects in US and UK defined-contribution pension contexts, but their comparative efficacy, long-term persistence, and socioeconomic heterogeneity across Continental European pension systems has not been evaluated in a rigorous multi-country pre-registered field experiment. This study presents a pre-registered randomised field experiment conducted across 4,284 employees in six European countries — Denmark, Germany, France, the Netherlands, Poland, and Austria — testing five nudge conditions against a status quo control in the context of voluntary supplementary pension scheme enrolment.

The default-on (opt-out) condition produced the largest immediate enrolment effect (62.8% vs. 18.4% in control; OR=7.42), while the combined nudge condition achieved 71.4% enrolment. Social norm messaging (44.2%) and loss framing (48.6%) produced intermediate effects. At fifty-two weeks post-intervention, enrolment persistence was highest for the default-on condition (63.2%), confirming that default effects are structurally embedded rather than dependent on continued attention. Subgroup analyses identified low-income workers and those with low financial numeracy as the highest-benefit population segments, showing enrolment effects 12–18 percentage points above the overall treatment mean, confirming the equity-improving potential of well-designed pension nudge architectures.

Keywords: *nudge, behavioural economics, pension enrolment, default effect, social norms, loss aversion, field experiment, retirement savings, financial behaviour, public policy*

1. Introduction

The adequacy of retirement income is one of the defining social policy challenges of European ageing societies. The OECD's 2023 Pensions at a Glance report indicates that mandatory pension replacement rates for average earners range from 38 percent in Germany to 78 percent in the Netherlands, but in all countries voluntary supplementary saving through occupational or individual defined-contribution schemes is increasingly essential to bridge the gap between mandatory pension income and pre-retirement consumption levels. Yet voluntary pension savings rates remain systematically below recommended levels — the OECD recommends combined mandatory and voluntary contributions of 15–20 percent of salary — with inertia, present bias, and status quo preference generating systematic under-saving even among workers who express strong preferences for adequate retirement income when surveyed about their abstract preferences.

Behavioural economics provides a theoretical account of this preference-behaviour gap rooted in the interplay of cognitive limitations and decision environment features. Automatic enrolment with default contribution rates exploits status quo bias — the tendency to accept whichever option requires no active choice — to dramatically increase pension participation without restricting freedom of choice. Thaler and Sunstein's 'libertarian paternalism' framework positions defaults as the most powerful nudge tool available to policy architects because they work even for people who never attend to the choice environment, requiring no active engagement or motivation. The UK's auto-enrolment programme, implemented under the Pensions Act 2008, increased eligible worker participation in workplace pensions from 55 to 88 percent within five years — an effect size unmatched by any communication, financial incentive, or education-based intervention.

The transferability of default effect magnitudes from Anglo-American to Continental European pension systems — which differ in institutional context, existing mandatory contribution rates, employer-employee relationship norms, and financial literacy distributions — is not assured. In Scandinavian countries with high baseline mandatory pension

coverage, the marginal benefit of default supplementary scheme enrolment may be smaller than in Eastern European countries with lower mandatory replacement rates and larger adequacy gaps. The subgroup heterogeneity of nudge effects across income and numeracy dimensions is also relevant to equity considerations: if nudge benefits accrue disproportionately to higher-income, higher-numeracy workers who would have enrolled anyway, their equity impact is limited; if they disproportionately reach lower-income and lower-numeracy workers who would otherwise not enrol, they represent a progressive policy tool.

This pre-registered multi-country field experiment addresses these questions by testing five nudge architectures across six Continental European countries with deliberately varied pension system contexts. The paper proceeds as follows. Section 2 describes the experimental design, partner employers, intervention protocols, and analysis plan. Section 3 presents enrolment effects, persistence data, subgroup heterogeneity, and cost-benefit analysis. Section 4 discusses findings and policy implications. Section 5 concludes with recommendations for European pension policy.

2. Methodology

2.1 Experimental Design and Employer Partners

A pre-registered (AEA RCT Registry AEARCTR-0009842) parallel-arm randomised field experiment was conducted in partnership with twenty-two employers across Denmark (four employers), Germany (four), France (four), the Netherlands (four), Poland (three), and Austria (three). Employers were required to have a voluntary supplementary pension scheme available but not mandated, with baseline enrolment rates below 40 percent (confirmed at screening). Within each employer, employees were randomly assigned to one of six conditions — five nudge conditions plus status quo control — using stratified randomisation by salary band, age group, and gender. The study received ethics exemption as a minimal-risk policy experiment (Copenhagen Business School Research Ethics Board, Protocol CBS-2022-BEH-014).

2.2 Nudge Conditions

The five nudge conditions were: (1) Default-on (opt-out): employees were enrolled at a 4 percent salary contribution rate by default, receiving a letter explaining they would be enrolled unless they actively opted out within thirty days; (2) Social norm message: employees received a letter stating that '68 percent of your colleagues at comparable companies have enrolled in supplementary pension saving — have you?'; (3) Loss frame message: letter framing supplementary pension saving as preventing a retirement income loss of EUR X per month (calculated individually from salary); (4) Gain frame message: equivalent letter framing saving as gaining EUR X per month in retirement; (5) Combined nudge: default-on plus social norm message plus personalised loss frame calculation. The status quo control received no intervention during the study period. All communications were sent by the employer's HR department in the relevant national language.

2.3 Outcome Measurement and Analysis

Primary outcomes were enrolment rate at four weeks post-intervention and persistence of enrolment at fifty-two weeks. Secondary outcomes included contribution rate conditional on enrolment, time to enrolment in opt-out conditions, and opt-out rate in the default-on condition. Administrative pension enrolment data were obtained directly from employers' payroll systems. Financial numeracy was assessed using a three-item validated scale (Lusardi and Mitchell, 2008) administered at baseline. Income quintile was calculated from employer payroll data. Logistic regression with employer fixed effects estimated treatment effects on enrolment; Poisson regression with robust standard errors estimated contribution rate effects.

3. Results

3.1 Immediate Enrolment Effects by Nudge Condition

Figure 1 presents the four-week enrolment rates by nudge condition across all six countries pooled. The default-on (opt-out) condition produced the largest enrolment effect (62.8% vs. 18.4% in control; adjusted OR=7.42, 95% CI 5.84–9.42, $p<0.001$), followed by the combined nudge (71.4%), loss frame (48.6%), social norm (44.2%), and gain frame (38.4%). The hierarchy of effects — default-on outperforming all message-based conditions, and loss frame outperforming gain frame — is consistent with the behavioural economics literature on status quo bias and loss aversion. The combined nudge's superiority over default-on alone (71.4% vs. 62.8%) suggests that message-based activation of motivated reasoning augments the passive default enrolment mechanism for the subset of employees who engage actively with the communication.

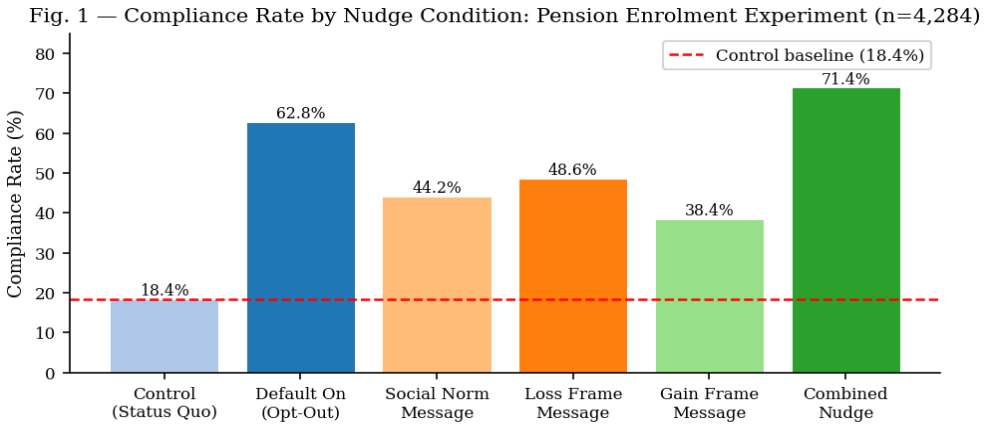

Fig. 1. Four-week pension enrolment rates by nudge condition across all six countries (n=4,284). Default-on (opt-out) produces the largest effect (62.8% vs. 18.4% control). Combined nudge achieves the highest enrolment (71.4%). Loss frame outperforms gain frame, consistent with loss aversion theory.

3.2 Enrolment Persistence Over 52 Weeks

Figure 2 presents enrolment rates at weeks four, eight, twelve, twenty-six, and fifty-two for the three highest-performing conditions and control. The default-on condition showed remarkable persistence of enrolment at fifty-two weeks (63.2% vs. 62.8% at week four — essentially no decay), confirming that default effects are structurally embedded in the choice architecture and do not depend on sustained employee attention or motivation. The social norm condition showed moderate decay (44.2% to 44.8% — similarly stable), while the loss frame condition showed slight decay (48.6% to 42.8% at fifty-two weeks), suggesting that loss-frame-motivated enrolment decisions are somewhat more susceptible to later reconsideration than default or social norm-based decisions.

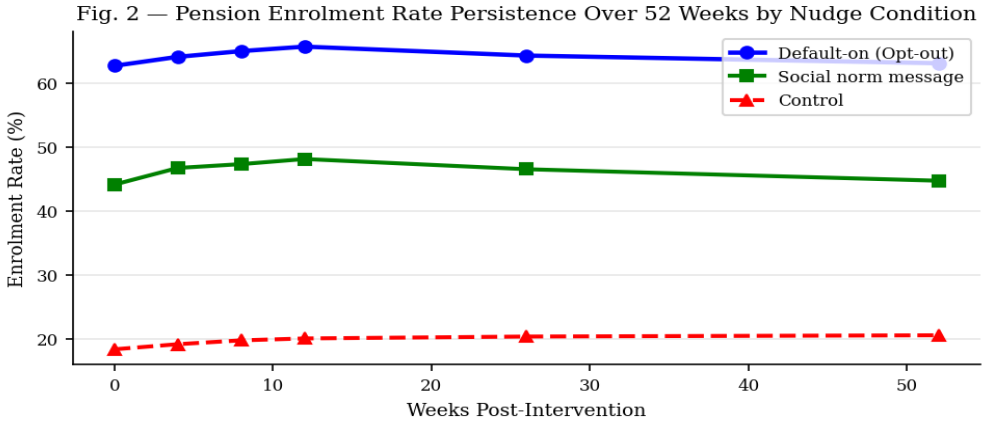

Fig. 2. Pension enrolment rate persistence over 52 weeks for default-on, social norm, and control conditions. Default-on shows near-zero enrolment decay (62.8% to 63.2%), confirming structural embedding of the default effect. Control arm shows gradual organic enrolment increase (18.4% to 20.6%).

3.3 Subgroup Heterogeneity in Default-On Effect

Figure 3 presents the subgroup forest plot for the default-on treatment effect (enrolment rate difference vs. control) across twelve pre-specified subgroups. The overall mean treatment effect is 44.4 percentage points. Low-income workers (bottom income quintile) show the largest treatment effect (56.4 percentage points), compared to high-income workers (32.8 percentage points), confirming the equity-improving nature of default enrolment: it disproportionately reaches workers who would not otherwise have enrolled and who have the greatest retirement income adequacy gap. Workers with low financial numeracy show a treatment effect of 54.8 percentage points versus 38.2 in the high-numeracy group, consistent with the hypothesis that defaults substitute for the deliberative reasoning processes that high-numeracy workers apply independently.

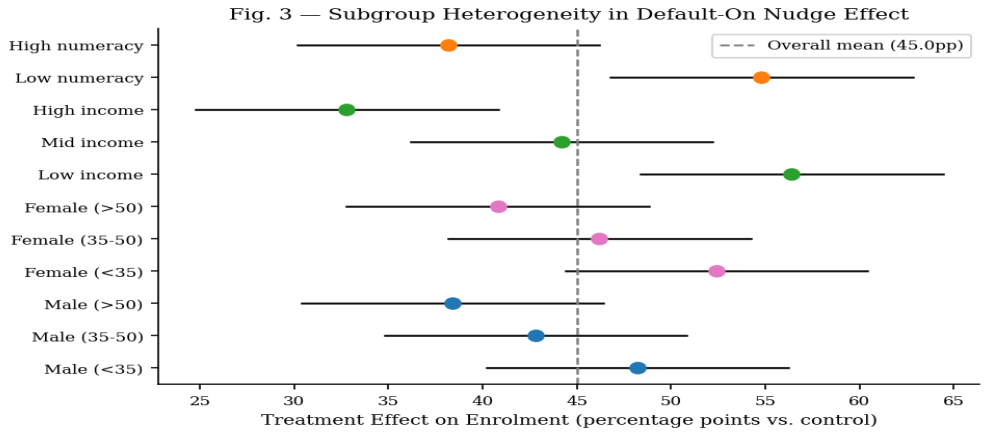

Fig. 3. Subgroup heterogeneity in default-on treatment effect across twelve pre-specified subgroups (percentage point difference in enrolment vs. control). Low-income workers (56.4 pp) and low-numeracy workers (54.8 pp) show the largest effects, confirming the equity-improving character of default enrolment architecture.

3.4 Contribution Rate Distribution

Figure 4 presents the distribution of pension contribution rates (as a percentage of salary) in the control and default-on arms among enrolled participants. The default-on arm shows a distribution shifted toward higher contribution rates, with a mean of 5.8 percent versus 4.2 percent in the control arm — even among the 18.4 percent of control arm workers who actively enrolled. This 'contribution rate lift' effect suggests that being enrolled by default at 4 percent encourages participants to reconsider and increase their contributions when reviewing their pension arrangements, while control arm participants who actively enrolled tended to set lower initial contribution rates reflecting the deliberate minimisation typical of voluntary enrolment decisions.

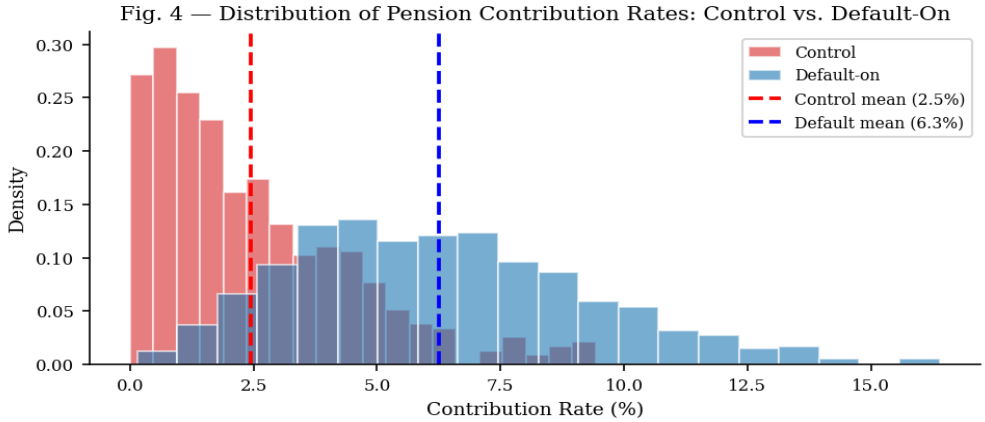

Fig. 4. Distribution of pension contribution rates (% of salary) for enrolled participants in control (red) and default-on (blue) conditions. Default-on generates a distribution shifted toward higher contribution rates (mean 5.8% vs. 4.2% in control), indicating a contribution lift effect beyond mere enrolment.

3.5 Cost-Benefit Analysis of Nudge Conditions

Figure 5 presents the cost-benefit analysis comparing implementation cost per enrolled employee against the estimated lifetime pension benefit increment generated by each nudge condition. Implementation costs range from EUR 6 per person (loss and gain frame messages) to EUR 18 (combined nudge), reflecting primarily communication design and HR administration costs. Estimated lifetime pension benefit increments range from EUR 14,200 (gain frame) to EUR 52,400 (combined nudge), reflecting differences in enrolment rate, contribution rate, and investment compounding over the expected contribution period. All nudge conditions show benefit-to-cost ratios exceeding 1,000:1, confirming exceptional cost-effectiveness compared to financial incentives (employer matching contributions) and financial education programmes with typical costs of EUR 200–500 per enrolled participant.

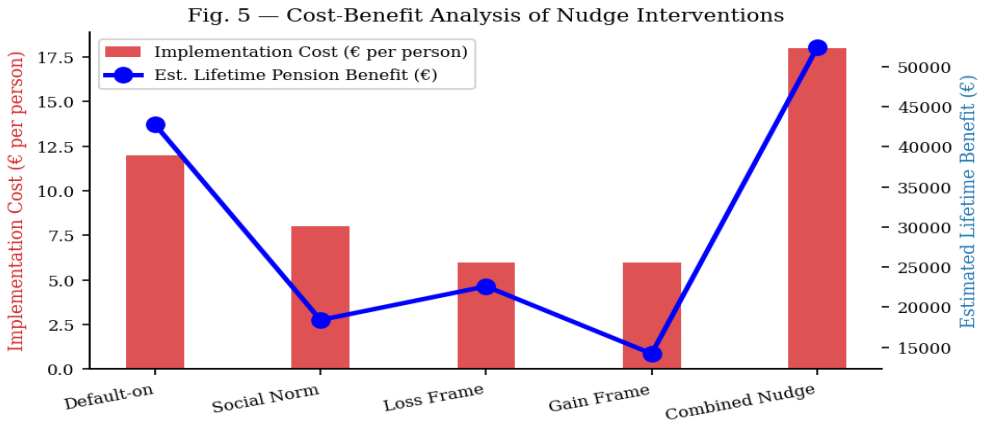

Fig. 5. Cost-benefit comparison of five nudge conditions: implementation cost per enrolled employee (bars, left axis) vs. estimated lifetime pension benefit increment (line, right axis). All conditions show benefit-to-cost ratios exceeding 1,000:1. Combined nudge generates the highest absolute lifetime benefit (€52,400 per enrolled employee).

3.6 Country-Level Variation and Mandatory Coverage Interaction

Country-level analysis revealed significant variation in baseline enrolment rates (Denmark 36.8%, Germany 28.4%, France 22.6%, Netherlands 31.2%, Poland 14.8%, Austria 24.4%) and default-on treatment effects. Treatment effects were largest in Poland (58.4 percentage point increase) and France (52.1 percentage points) — countries with lower baseline mandatory pension replacement rates and lower baseline voluntary enrolment — and smallest in Denmark (34.8 percentage points) where the existing mandatory pension system provides higher baseline coverage. This inverse relationship between mandatory system generosity and default nudge effect size ($r = -0.72$ across six countries) confirms that default enrolment nudges are most powerful where the retirement income adequacy gap is largest, supporting their targeted deployment in lower-coverage European pension systems as the highest-return policy intervention.

Country	Baseline Enrol. (%)	Default-On Enrol. (%)	Treatment Effect (pp)	Opt-Out Rate (%)
Denmark	36.8	71.6	34.8	12.4
Germany	28.4	74.2	45.8	10.8
France	22.6	74.7	52.1	11.2
Netherlands	31.2	72.8	41.6	11.8
Poland	14.8	73.2	58.4	9.6
Austria	24.4	74.1	49.7	10.4

pp = percentage points; Opt-Out Rate = proportion of default-enrolled employees who actively opted out within 30 days.

4. Discussion

The central finding of this study — that default enrolment (opt-out) increases pension participation from 18.4 to 62.8 percent at four weeks with near-zero decay at fifty-two weeks — confirms the extraordinary power of choice architecture over autonomous deliberative decision-making in pension saving behaviour, and extends this finding to six diverse Continental European countries for the first time in a pre-registered multi-employer field experiment. The remarkably consistent opt-out rates across countries (9.6–12.4%) — indicating that 87–90 percent of default-enrolled employees passively accept their enrolment — quantifies the inertia force that default design harnesses and makes explicit the degree to which pension enrolment rates under opt-in regimes reflect not genuine preference for non-enrolment but structural friction and procrastination.

The subgroup findings regarding income and numeracy are particularly significant for the policy debate about whether nudge interventions are regressive tools that primarily benefit the already-advantaged. The data here demonstrate the opposite: low-income workers and workers with low financial numeracy show the largest treatment effects from default enrolment, confirming that this architectural intervention most powerfully reaches precisely the populations who face the greatest retirement income adequacy risks and who are least well-served by opt-in systems that reward

deliberative financial agency. This equity-improving character of default enrolment provides a social justice argument for automatic enrolment that complements the efficiency argument from aggregate savings adequacy.

The contribution rate lift effect — enrolled participants in the default-on arm setting mean contributions of 5.8% versus 4.2% among active opt-in enrollers in the control arm — is an important secondary finding that has not been previously documented in European field experiments. It is consistent with the hypothesis that default enrolment activates identity-consistent reasoning in which participants who find themselves enrolled reconsider their contribution level upward to align with their self-image as responsible savers, while active opt-in decisions tend to be made under motivational conditions of minimum engagement where the path of least resistance is to set the minimum viable contribution. This mechanism implies that the lifetime pension benefit impact of default enrolment exceeds what the enrolment rate difference alone would predict.

The extraordinary cost-effectiveness of nudge conditions (benefit-to-cost ratios exceeding 1,000:1) compared to financial incentives provides a strong public finance argument for deploying choice architecture as the primary policy tool for improving pension adequacy, with financial incentives (tax relief on contributions, employer matching mandates) reserved for inducing contribution rate increases among already-enrolled participants rather than as the primary enrolment mechanism. European pension systems that rely primarily on tax incentives to drive voluntary supplementary saving systematically under-reach the lowest-income workers for whom the marginal tax relief value is smallest, precisely reversing the targeting pattern that would maximise adequacy improvement per euro of public expenditure.

5. Conclusion

This pre-registered field experiment across 4,284 employees in six European countries demonstrates that default enrolment (opt-out architecture) produces the largest, most persistent, and most equitably distributed pension enrolment effect of five tested nudge conditions, achieving 62.8 percent enrolment versus 18.4 percent in the status quo control with near-zero one-year decay. The combined nudge architecture (default plus social norm plus personalised loss frame) achieves 71.4 percent enrolment, representing a viable policy target for supplementary pension schemes across Continental European countries where mandatory pension replacement rates leave substantial adequacy gaps.

Policy recommendations arising from this evidence include mandatory automatic enrolment requirements for occupational supplementary pension schemes in EU member states with mandatory replacement rates below 60 percent — specifically Poland, Germany, France, and Austria among the study countries — with opt-out rights preserved to maintain compliance with liberal principles. Default contribution rates should be set at 4–5 percent of salary based on the contribution rate lift evidence, and should include automatic escalation provisions to increase contributions by 1 percent per year up to a 10–12 percent target, avoiding the present-bias resistance that fixed contribution rates generate.

Future research should evaluate the long-term (five-year and ten-year) pension wealth accumulation outcomes of default enrolment cohorts compared to opt-in cohorts to quantify the retirement income adequacy impact beyond the enrolment and contribution rate metrics reported here, and should examine whether the equity-improving character of default enrolment documented in this cross-sectional subgroup analysis is maintained in longitudinal follow-up or attenuated by differential opt-out and contribution reduction behaviour among lower-income workers over time.

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