

Nudging pension saving decisions

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Voorwoord

Ruim tien jaar geleden stond ik op een belangrijk kruispunt in mijn leven: Zou ik mijn topsportcarrière verderzetten, met het vooruitzicht om als professioneel acrobaat de wereld rond te reizen met Cirque du Soleil? Of zou ik mij volledig toeleggen op mijn andere passie: Het doorgronden van de menselijke psyche en hoe onze briljante breinen ons systematisch in de steek laten bij het maken van keuzes? Hoewel ik uiteindelijk niet koos voor een carrière in het circus, heeft het leven een bijzondere manier om cirkels rond te maken. Want als ik terugblik op mijn doctoraatstraject, voelt het alsof ik jarenlang deel uitmaakte van een waar circus, compleet met alle magie, verwondering, spanning en nodige *‘hoe de f*ck heeft die dat gedaan’* die je normaal gesproken enkel in een écht circus tegenkomt.

De afgelopen vier jaar was ik niet de meest traditionele, doorsnee doctoraats-onderzoeker, maar eerder een professioneel jongleur die tal van projecten in de lucht hield: De vier omvangrijke empirische studies in dit proefschrift, samen goed voor meer dan 18,000 deelnemers; drie bijkomende academische papers waarvan één reeds gepubliceerd werd in het tijdschrift Bank-en Financiën, terwijl de twee anderen hun weg banen door het peer-review proces; en het begeleiden van tientallen studenten voor stages, masterproeven en groepswerken.

Als doctorandi worden we betaald door de belastingbetaler. De wetenschap die we produceren, vindt echter niet altijd even makkelijk haar weg terug naar het brede publiek. Daarom vond ik het ook belangrijk om mijn steentje in de wetenschapscommunicatie bij te

dragen met initiatieven zoals de UGent@Work kennisclips, de Gentse Economische Inzichten en meer dan honderd interviews voor radio, kranten, tijdschriften en tv.

Verder geraakte ik verzeild in verschillende *side quests*: Een grootschalig veldonderzoek met Bol.com, De FOD Binnenlands Bestuur die hulp nodig had bij het opstellen van de vaccinatie-oproepbrieven tijdens de COVID-19 pandemie, een onderzoeksproject met Deloitte waarbij we de financiële gezondheid van de Belg in kaart brachten en de nationale media haalden, en meer.

Alsof deze academische jongleeract nog niet genoeg spanning bood, voerde ik parallel, in de tent ernaast, ook een tweede show op: Samen met mijn co-founder *Toto De Brant*, bouwde ik tijdens mijn doctoraat ook een startup uit tot een team van 13. Na enkele woelige jaren, waarin we een stevige portie uitdagingen overwonnen, realiseerden we in 2024 een succesvolle exit. Nog voor de inkt van de overname droog was, richtten we al meteen een nieuwe startup op, die we '*Alkmist*' doopten. We bouwden een state-of-the-art applicatie uit, voltooiden een succesvolle eerste kapitaalsronde en bouwden opnieuw een sterk team uit.

Het combineren van deze twee werelden was vaak een delicate evenwichtsoefening. Cruciale deadlines in beide projecten leken een magnetische aantrekkingskracht tot elkaar te hebben, en wanneer het doctoraat extra aandacht en liefde nodig had, leek de onderneming dat plots ook te doen. Hoewel het zeker geen wandeling door het park is geweest, heeft net die continue uitdaging om verschillende ballen in de lucht te houden me sterker gemaakt. Het heeft me geleerd om te floreren in chaos, om kansen te zien en creëren in crisismomenten, en om door te zetten wanneer opgeven de makkelijkste optie leek.

Als ik nu terugkijk op deze periode, verbaast het me nog steeds hoe de puzzel uiteindelijk in elkaar is gevallen. Wat begon als een ogenschijnlijk onmogelijke combinatie, werd een unieke periode in mijn leven die me niet alleen als onderzoeker, maar ook als ondernemer en als mens heeft gevormd.

Maar de magie die een circus draaiende houdt, speelt zich niet enkel af op het podium, maar vooral in het sterke team achter de schermen, het publiek, de vangnetten en verschillende andere artiesten die deze zotte show mee mogelijk maakten. Zonder hen zou dit avontuur onmogelijk zijn geweest. Deze mensen verdienen een welgemeend woord van dank.

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niet alleen geholpen om meerdere grote branden in onze ondernemerstent te voorkomen, maar ook, wanneer er iets begon te smeulen, om tijdig en doeltreffend in te grijpen. Of het nu gaat om persoonlijke of zakelijke uitdagingen, jullie zijn altijd de eersten bij wie we aankloppen voor advies. We weten dat we steeds kunnen rekenen op jullie eerlijke feedback en waardevolle inzichten. Jullie voortdurende steun betekent meer dan woorden kunnen uitdrukken.

Alex McGraw, my guy, despite the ocean between us, you've been instrumental in keeping me sane throughout these years. Finding time to meet in person hasn't always been easy, but I'm truly grateful for the moments we've shared. I'm especially glad that I was 'completely by coincidence' able to find a relevant conference in the States, giving us the opportunity to spend some quality time together. Let's make it a priority to create more of those moments in the near future.

Een oprechte dank aan mijn ouders, mijn broer en mijn schoonfamilie voor hun onvoorwaardelijke steun. *Mama* en *papa*, jullie geloofden altijd in mij, gaven me alle kansen en leerden *Joren* en mij de waarden en normen die ons zoveel deuren hebben geopend. Jullie hebben niet alleen een stabiele thuisbasis gecreëerd, maar ook een hechte familie waar ik enorm trots op ben. De dagelijkse telefoontjes, de steun op moeilijke momenten en het vertrouwen dat jullie me altijd gaven, hebben me geholpen om vol te houden. Zonder jullie had ik dit niet kunnen bereiken. *Joren*, als grote broer stond je de afgelopen vier jaar altijd klaar als klankbord, terwijl je zelf indrukwekkende stappen zette in je eigen carrière. Jouw advies en steun betekenen enorm veel voor mij. Mijn schoonfamilie, ook jullie wil ik bedanken. Jullie zorgden altijd voor een warm welkom, een vers bord eten en de nodige afleiding wanneer dat nodig was. Jullie stonden er altijd, zelfs op last-minute momenten, en dat heeft het verschil gemaakt.

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professionele partners hebben die ons op korte én lange termijn zullen helpen Alkmist groot te maken, maar ook mensen met wie het oprecht aangenaam samenwerken is en op wie we kunnen bouwen, zowel in uitdagende als in mooie tijden. In dit verlengde wil ik ook *Willem Dumon*, *Matthias De Witte* en *Frederic De Witte* bedanken. Jullie ervaring en expertise als ondernemers, gecombineerd met jullie onvoorwaardelijke steun en geloof in ons, spelen een cruciale rol in de groei van Alkmist. Ik kijk er enorm naar uit om met jullie aan onze zijde deze startup naar het volgende niveau te tillen. Jullie betrokkenheid en bereidheid om mee te denken en te ondersteunen, maken het verschil en daarvoor ben ik jullie ontzettend dankbaar.

Toto De Brant, mijn co-founder, mijn ondernemende wederhelft. NU BEN IK ÉCHT ÉCHT KLAAR. De afgelopen jaren heeft onze circustent meermaals in lichterslaai gestaan, je zou kunnen zeggen dat ze zelfs bijna volledig is afgebrand. Maar ondanks dat dit de meest uitdagende jaren voor ons beiden als ondernemers waren, bleven we bij elkaar. We kozen er elke dag opnieuw voor om samen te blijven ondernemen. Ik ben je enorm dankbaar dat ook jij steeds opnieuw voor mij kiest, wetende dat ik de afgelopen jaren een deel van de tijd shows aan het opvoeren was in een andere circustent. Andere ondernemers hadden dat waarschijnlijk minder goed verteed, maar jij bleef vertrouwen, ruimte en een klankbord bieden. Deze periode heeft me niet alleen veel geleerd over mezelf, maar vooral over de persoon met wie ik het nauwst en liefst samenwerk. Ik kijk ernaar uit om mijn volle energie, tijd en focus in onze startup te steken, en vooral om dat samen met jou te doen. Ik zou het met geen andere co-founder willen doen.

En last but not least, dr. *Mona Bassleer*, mijn madam. Waar begin ik? Zonder jou was er geen doctoraat. Zonder jou was er geen onderneming. Écht waar. Van alle mensen die ik hier bedank, verdien jij de grootste staande ovatie. Ze zeggen wel eens dat naast elke sterke man een dubbel zo sterke vrouw staat; maar in jouw geval is dat een zwaar understatement. Je werd regelmatig meegezogen in de draaikolk van mijn drukke agenda (Sorry daarvoor),

waarbij je geen twee keer moest nadenken om mij weer eens last minute te helpen wanneer ik je nodig had. Jij was er ALTIJD. Dit afgelopen hoofdstuk was pittig, want ook jij was een eigen doctoraat aan het schrijven, dat je notabene als enige van het ganse lab binnen de originele deadline wist af te werken. Je was niet alleen mijn steun en toeverlaat in moeilijke momenten, maar hielp ook dermate inhoudelijk met data-analyses, je zorgde dat ik geen deadlines miste of APA regels vergat. Hierdoor ben je ook, meer dan terecht, co-auteur op nagenoeg al mijn papers. Mijn naam op jouw papers? Die luxe heb jij niet gehad. We hebben niet enkel samen, vanuit hetzelfde lab, een doctoraat weten af te maken, maar vierden ook nog eens ons 10-jarige jubileum. Jij bent mijn rots in de branding, de geheime kracht achter mijn vermogen om alle verschillende projecten te jongleren.

En nu? Het jongleren zit intussen in mijn vingers, maar waar mijn tijd na het doctoraat naartoe gaat? Niet naar het volgende grote nieuw project, maar naar wat écht telt. Ik kijk ernaar uit om het volgende hoofdstuk in ons leven te beginnen. Samen leven met een ondernemer zal altijd een beetje beetje aanvoelen als een circus, maar na deze periode weet ik dat we samen alles aankunnen. En wie weet komt er in de toekomst nog een extra balletje bij om samen in de lucht te houden.

Gent, 21 Januari 2025
Mathias Celis

Samenvatting

Nog nooit in de geschiedenis was het leven zo goed als in de 21ste eeuw. De globale levensverwachting en opleidingsniveau bereiken historische records, ziektes als rode hond, polio en pokken werden nagenoeg volledig uitgeroeid, terwijl slechts 8.5% van de wereldbevolking onder de armoedegrens leeft (World Bank, 2024). Deze indrukwekkende vooruitgang komt echter met een keerzijde: De combinatie van een snel vergrijzende bevolking en ingrijpende economische verschuivingen maakt het steeds moeilijker om financiële zekerheid te garanderen doorheen de levenscyclus, wat zich manifesteert in een pensioenstelsel dat onder ongekende druk staat (Miles, 2023; OECD, 2023).

De stijgende levensverwachting, in combinatie met dalende geboortecijfers, heeft wereldwijd de bevolkingsstructuur ingrijpend veranderd (Oeppen & Vaupel, 2002; Riley, 2005). Tegen 2050 wordt verwacht dat meer dan driekwart van de landen een vruchtbaarheidscijfer zal hebben dat lager ligt dan het vervangingsniveau van 2.1 kinderen per vrouw, dat nodig is om populatiestabiliteit te waarborgen (Bhattacharjee et al., 2024; Eurostat, 2024). Tegelijkertijd is de wereldwijde levensverwachting bijna verdubbeld sinds de 19de eeuw, met verschillende Europese landen waar mensen vandaag gemiddeld ouder dan 84 jaar worden. (Miles, 2023; OECD, 2023). Deze ontwikkeling zet pensioenstelsels onder grote druk, aangezien een steeds kleinere groep werkenden de last moet dragen van een snel groeiende groep ouderen (Bayar, 2018; OECD, 2023).

Deze demografische uitdagingen worden versterkt door een bredere verschuiving van institutionele naar individuele financiële verantwoordelijkheid (Anderson, 2015; Barr &

Diamond, 2009). Volgens voorspellingen moeten jongere generaties ongeveer 40% meer sparen dan hun ouders om vergelijkbare financiële zekerheid te bereiken (EU commission, 2023). Ondanks deze urgente noodzaak leiden gedragsbarrières, zoals *present bias*, verliesaversie, en *status quo bias* ertoe dat mensen toekomstige voordelen systematisch onderwaarden of belangrijke financiële beslissingen uitstellen (Kahneman & Tversky, 1979; Laibson, 1997).

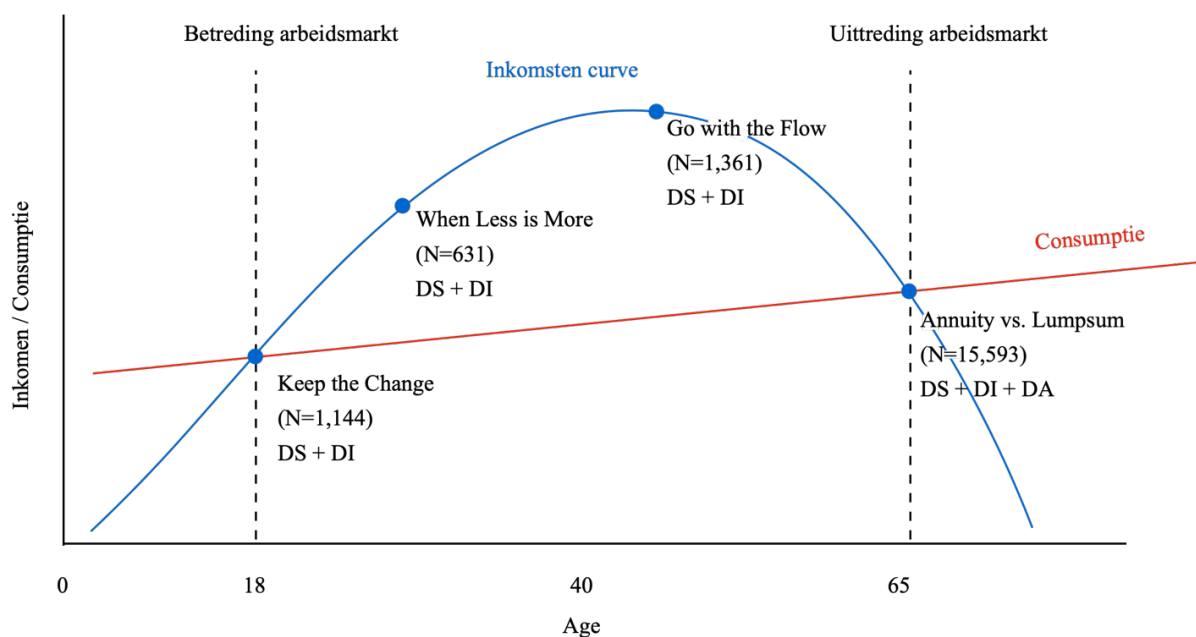
Om deze uitdagingen aan te pakken, onderzoekt dit doctoraatsproefschrift hoe gedragsinterventies pensioenkeuzes gedurende de levensloop kunnen verbeteren. Door middel van vier empirische studies met meer dan 18,000 deelnemers onderzoeken we verschillende cruciale kennishiaten: **(1)** het gebrek aan systematische vergelijkingen tussen verschillende soorten gedragsinterventies (*Decision Structure* (DS) / *Decision Assistance* (DA) / *Decision Information* (DI)) binnen Europese welvaartsstelsels, **(2)** de beperkte focus op binaire uitkomsten, zoals deelnemen vs. niet deelnemen, in plaats van de invloed van interventies op meer granulaire bijdrageniveaus, **(3)** de onderbestudeerde synergie- of interactie-effecten bij het combineren van verschillende soorten interventies (DS/DA/DI), **(4)** de beperkte toepasbaarheid van bevindingen uit Amerikaanse context op Europese welvaartsstelsels met hun unieke institutionele en sociale context, en **(5)** de ontoereikende verkenning van de onderliggende cognitieve mechanismen voorbij traditionele *dual-process* theorieën in het begrijpen hoe interventies pensioenbeslissingen beïnvloeden.

Uitgaande van Modigliani's (1986) *Life-Cycle Hypothese* als raamwerk en voortbouwend op de categorisering van gedragsinterventies volgens Mertens et al.'s (2022), onderzoeken we in dit doctoraatsproefschrift systematisch hoe verschillende soorten gedragsinterventies kunnen inspelen op gedragsbarrières die bijdragen aan betere financiële beslissingen op scharnierzakmomenten doorheen de levenscyclus.

De eerste studie onderzoekt financieel gedrag in de vroege levensfase, met focus op het stimuleren van de adoptie van micro-investeringen bij jongvolwassenen. De tweede studie verkent de effecten van tijdsframing op bijdragebeslissingen. De derde studie onderzoekt deelname aan bedrijfspensioenen halverwege de carrière, terwijl de vierde studie complexe opname beslissingen analyseert via een grootschalige mega-studie. Figuur 1 visualiseert onze vier empirische studies op een adaptatie van de levenscyclustheorie van Modigliani (1986) en illustreert hoe verschillende gedragsinterventies specifieke uitdagingen in elke fase aanpakken. De blauwe curve geeft het inkomen gedurende het leven weer, terwijl de rode lijn consumptiepatronen visualiseert.

Figuur 1

Onderzoeksoverzicht: Een Levenscyclusbepijndering van pensioenbeslissingen



Noot. De figuur koppelt de vier empirische studies in dit proefschrift aan het levenscyclus-inkomensmodel van Modigliani (1986). DS= Decision Structure, DI= Decision Information, DA= Decision Assistance.

Volgend op het eerste inleidende hoofdstuk waar een brede maatschappelijke kadering wordt geschetst, onderzoeken we in Hoofdstuk 2, *'Keep the Change'*, hoe gedragsinterventies jongvolwassenen ($N = 1,144$) kunnen stimuleren om met micro-investeringen te beginnen via een geautomatiseerd afrondingsprogramma dat wisselgeld van dagelijkse transacties investeert. Via een vignette-experiment dat standaardopties en dynamische groepsnormen test, ontdekken we dat standaardkeuzes de deelname aanzienlijk verhogen (60.5% versus 34.2%, Cohen's $d = 0.55$). Sociale norminterventies toonden echter geen significant effect, wat vraagtekens zet bij aannames over de invloed van leeftijdsgenoten bij financiële beslissingen. Deze bevindingen suggereren dat het wegwerken van drempels door automatische aanmelding effectiever kan zijn dan sociale vergelijkingsstrategieën voor het stimuleren van investeringsgedrag in de vroege levensfase.

Hoofdstuk 3, *'When Less is More'*, onderzoekt hoe tijdsframing invloed heeft op pensioenbijdragebeslissingen. In een vignettestudie ($N = 631$) ontdekken we dat een dagelijkse framing van bijdragen de verwachte maandelijkse bijdrage aan een pensioenfonds met ongeveer 27% verhoogde ten opzichte van wekelijkse framing (€106.87 vs. €84.28) en met 17% ten opzichte van maandelijkse framing (€91.15). Opvallend genoeg leidden zowel sociale als numerieke ankerpunten tot lagere spaarbedragen vergeleken met de controlegroep, wat suggereert dat expliciete referentiepunten mogelijk een averechts effect hebben bij persoonlijke financiële beslissingen. Deze bevindingen verbreden het onderzoek naar tijdsframing naar een Europese context en benadrukken belangrijke grenzen aan sociale beïnvloeding bij pensioenplanning.

Hoofdstuk 4, *'Go with the Flow'*, onderzoekt het effect van standaardopties en dynamische normen bij werkgerelateerde pensioenbeslissingen. Onder 1,361 werknemers verhoogden opt-out standaardopties de deelname met 8.5 procentpunt (72.6% vs. 64.1%), ondanks aanzienlijke administratieve obstakels. Hoewel significant, is dit effect (Cohen's $d =$

0.21) opvallend kleiner dan wat doorgaans wordt gerapporteerd in Amerikaanse studies, wat mogelijks wijst op belangrijke institutionele verschillen in de effectiviteit van standaardkeuzes. Dynamische normen toonden geen significante impact, wat onze eerdere bevindingen over beperkte sociale invloed in Europese pensioencontexten verder ondersteunt.

Hoofdstuk 5, '*Annuity vs. Lumpsum*', presenteert een megastudie ($N = 15,593$) die 24 verschillende combinaties van gedragsinterventies onderzoekt bij pensioenopname-beslissingen. Opmerkelijk is dat standaardopties niet effectief blijken wanneer keuzes op een continue schaal worden aangeboden in plaats van binaire opties, terwijl DA interventies bescheiden positieve effecten toonden. Het onderzoek onthulde consistente beslissingspatronen over alle condities: Gemiddeld koos 51.2% voor minimale annuïtisering ($<5\%$), 34.5% koos voor een gemengde opname (lijfrente / eenmalig bedrag), en 14.3% koos om het volledige kapitaal om te zetten naar een lijfrente ($>95\%$). Deze bevindingen suggereren dat wanneer complexe financiële beslissingen op een continue in plaats van binaire schaal worden gepresenteerd, dit mogelijk een meer weloverwogen denkproces in gang zet dat traditionele effecten die in gedragsinterventies geobserveerd worde, vermindert of neutraliseert.

In onze algemene discussie (Hoofdstuk 6) reflecteren we op onze bevindingen uit de verschillende hoofdstukken en synthetiseren we belangrijke inzichten over gedragsinterventies in pensioenplanning. Gezamenlijk onthullen de studies in dit doctoraatsproefschrift belangrijke patronen over gedragsinterventies bij pensioenplanning. Ten eerste blijken standaardopties krachtige instrumenten voor het beïnvloeden van financiële beslissingen, maar hun effectiviteit varieert aanzienlijk afhankelijk van de keuzearchitectuur en specifieke context. Standaardopties tonen robuuste effecten bij binaire beslissingen maar verdwenen wanneer keuzes complexer of continu werden gepresenteerd. Ten tweede nam de effectiviteit van interventies meestal af naarmate de psychologische afstand toenam: Nudges

gericht op directe, concrete beslissingen (zoals dagelijks geformuleerde bijdragen of micro-investeringen) hadden meer impact dan interventies die gericht zijn op langetermijnnuitkomsten (zoals pensioenopnamestrategieën). Ten derde suggereren onze bevindingen binnen de Belgische pensioencontext dat gedragsinterventies mogelijk anders werken in sterke Europese welvaartstelsels dan eerder gedocumenteerd in Amerikaans onderzoek.

De inzichten uit dit doctoraatsproefschrift hebben belangrijke implicaties voor zowel theorie als praktijk. Ze wijzen op de noodzaak van meer genuanceerde benaderingen van gedragsinterventies gedurende de levenscyclus, vooral binnen Europese welvaartstaten. Hoewel gedragsinterventies effectief kunnen zijn bij financiële beslissingen in vroege levensstadia, zijn mogelijk geavanceerdere instrumenten nodig voor complexe pensioenkeuzes. Nu samenlevingen wereldwijd worstelen met demografische verschuivingen en een sterk toenemende druk op pensioenstelsels, bieden deze studies praktische inzichten voor het ontwikkelen van effectievere, contextgevoelige benaderingen om pensioenzekerheid te vergroten.

Summary

Never before in history has life been as good as in the 21st century. Global life expectancy and educational levels have reached record highs; diseases such as rubella, polio, and smallpox have been nearly eradicated; and only 8.5% of the world's population lives below the poverty line (World Bank, 2024). However, this remarkable progress comes with a downside: the combination of a rapidly aging population and profound economic shifts is making it increasingly difficult to ensure financial security throughout the life cycle, resulting in a pension system under unprecedented pressure (Miles, 2023; OECD, 2023).

Rising life expectancy, combined with declining fertility rates, has fundamentally reshaped population structures worldwide (Oeppen & Vaupel, 2002; Riley, 2005). By 2050, over three-quarters of countries are expected to experience fertility rates below the replacement level of 2.1 children per woman, which is needed to preserve population stability (Bhattacharjee et al., 2024; Eurostat, 2024). Simultaneously, global life expectancy has nearly doubled since the 19th century, with many European nations now reporting averages surpassing 84 years (Miles, 2023; OECD, 2023). These shifts have intensified pressures on pension systems, which must adapt to a rapidly ageing population because it is being supported by a shrinking workforce (Bayar, 2018; OECD, 2023).

Compounding these demographic challenges is a broader trend from institutional toward individualized financial responsibility (Anderson, 2015; Barr & Diamond, 2009). Projections suggest younger generations will need to save approximately 40% more than their parents to achieve comparable financial security (EU commission, 2023). Despite this urgent

need, behavioral barriers such as present bias, loss aversion, and status quo bias lead individuals to systematically undervalue future benefits or defer critical financial decisions (Kahneman & Tversky, 1979; Laibson, 1997).

To address these challenges, this PhD dissertation examines how behavioral interventions can improve pension decisions across the life cycle. Through four empirical studies involving over 18,000 participants, we address several critical knowledge gaps: **(1)** the lack of systematic comparisons between distinct types of behavioral interventions (Decision Structure (DS) / Decision Assistance (DA) / Decision Information (DI)) within European (EU) welfare systems, **(2)** the narrow focus on binary outcomes, such as enrollment decisions, rather than the influence of interventions on contribution levels, **(3)** the unexplored synergies or interference effects when combining different types of interventions (DS/ DA/DI), **(4)** the limited applicability of findings from U.S. settings to European welfare systems with their unique institutional and social contexts, and **(5)** the insufficient exploration of nuanced cognitive mechanisms beyond traditional dual-process theories in understanding how interventions affect pension decisions.

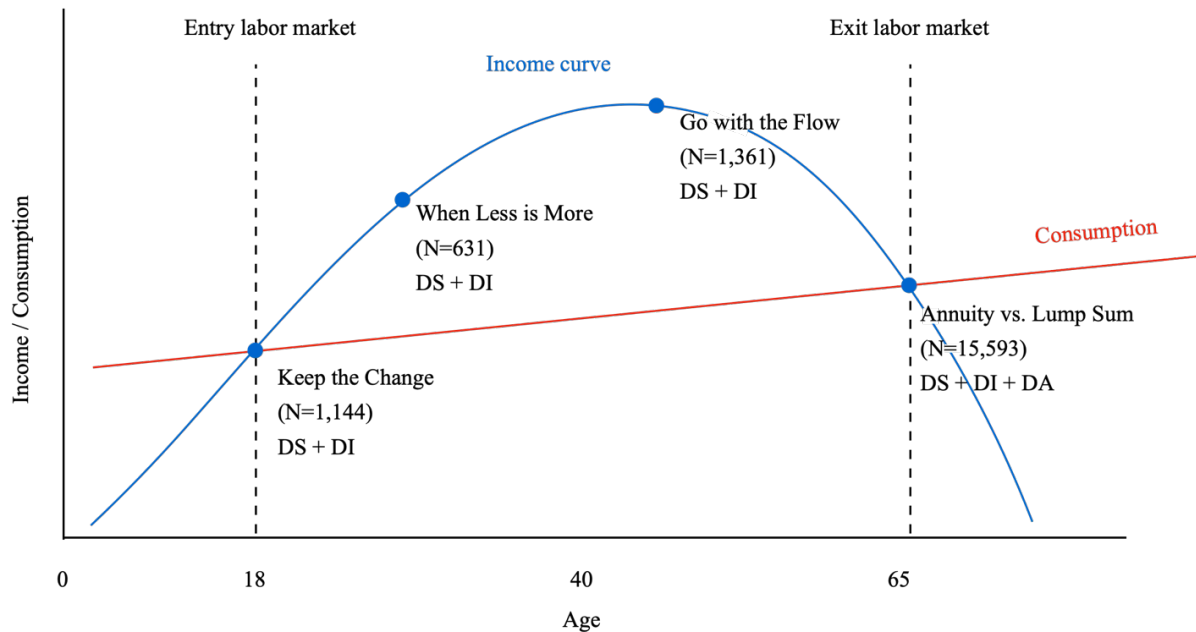
Using Modigliani's (1986) Life-Cycle Hypothesis as a framework and following Mertens et al.'s (2022) categorization of behavioral interventions, this PhD dissertation systematically examines how different types of behavioral interventions can leverage cognitive barriers to support better financial decisions at key moments during the life-cycle.

The first study investigates early-stage financial behaviors, focusing on micro-investing adoption among young adults. The second study explores temporal framing effects on contribution decisions. The third study examines occupational pension enrollment in mid-career, while the fourth study addresses complex decumulation decisions through a large-scale mega-study approach. Figure 1 maps our four empirical studies onto an adaptation of Modigliani's (1986) Life-Cycle theory, illustrating how different behavioral interventions

address specific challenges at each stage. The blue curve represents income across the lifespan, while the red line indicates consumption patterns.

Figure 1

Research Overview: A Life-Cycle Approach to Pension Decisions



Note. The figure maps the four empirical studies in this PhD onto the life-cycle income model by Modigliani (1986). DS= Decision Structure, DI= Decision Information, DA= Decision Assistance.

Following the first introductory chapter which outlines a broad societal framework, in Chapter 2 "Keep the Change," we investigate how behavioral interventions can encourage young adults ($N = 1,144$) to begin micro-investing through an automated roundup saving program that invests spare change from daily transactions. Through a vignette experiment testing set-and-forget defaults and dynamic peer norms, we find that defaults significantly increase enrollment (60.5% versus 34.2%, Cohen's $d = 0.55$). However, social norm interventions showed no significant effect, challenging assumptions about peer influence in

financial decisions. These findings suggest that reducing friction through automatic enrollment may be more effective than social comparison strategies for promoting early-stage investment behaviors.

Chapter 3, "When Less is More," explores how temporal framing influences retirement contribution decisions. In a vignette study ($N = 631$), we find that daily framing of contributions increased projected monthly savings by approximately 27% compared to weekly framing (€106.87 vs. €84.28) and 17% compared to monthly framing (€91.15). Surprisingly, both social and numerical anchors suppressed saving amounts compared to control conditions, suggesting potential backfire effects of explicit reference points in private financial decisions. These findings extend temporal reframing research to a European context, while highlighting important boundaries for social influence in retirement planning.

Chapter 4, "Go with the Flow," investigates default effects and dynamic norms in occupational pension decisions. Among 1,361 employees, opt-out defaults increased enrollment by 8.5 percentage points (72.6% vs. 64.1%) despite substantial administrative friction. While significant, this effect (Cohen's $d = 0.21$) is notably smaller than those typically reported in U.S.-based studies, suggesting important institutional differences in default effectiveness. Dynamic norms showed no significant impact, further supporting our earlier findings about limited social influence in European pension contexts.

Chapter 5 presents a mega-study ($N = 15,593$) examining 24 different nudge combinations in pension decumulation decisions. Notably, when presented with continuous rather than binary choices, defaults appear ineffective, while decision assistance tools showed modest positive effects. The study revealed consistent decision patterns across conditions: 51.2% opted for minimal annuitization ($<5\%$), 34.5% chose mixed strategies (Annuity & Lump Sum), and 14.3% selected high annuitization ($>95\%$). These findings suggest that when

complex financial decisions are presented on a continuous rather than binary scale, this may trigger more deliberative processing that overrides traditional nudge effects.

In our general discussion (Chapter 6), we reflect on our findings across chapters, synthesizing key insights about behavioral interventions in retirement planning. Collectively, these studies reveal several important patterns about behavioral interventions in retirement planning. First, while defaults remain powerful tools for influencing financial decisions, their effectiveness varies substantially with choice architecture. Default effects proved robust for binary decisions but disappeared when choices became more complex or continuous. Second, intervention effectiveness typically declined as psychological distance increased: nudges targeting immediate, concrete decisions (like daily-framed contributions or micro-investing) showed greater impact than those addressing distant outcomes (like decumulation strategies). Third, our findings within the Belgian pension context suggest behavioral interventions may operate differently in strong European welfare state environments than previously documented in U.S.-based research.

The insights gained from this PhD dissertation have important implications for both theory and practice. They suggest the need for more nuanced approaches to behavioral interventions across the life cycle, particularly within European welfare states. While behavioral interventions can effectively support early-life financial decisions, more sophisticated tools may be needed to address complex retirement choices. As societies worldwide grapple with demographic shifts and pension system pressures, this PhD research provides actionable insights for developing more effective, context-sensitive approaches to enhancing retirement security.

References

- Anderson, K. (2015). Pension Reform in Europe: Context, Drivers, Impact. In S. Scherger (Ed.), *Paid Work Beyond Pension Age: Comparative Perspectives* (pp. 177–197). Palgrave Macmillan UK. https://doi.org/10.1057/9781137435149_8
- Barr, N., & Diamond, P. (2009). Reforming pensions: Principles, analytical errors and policy directions. *International Social Security Review*, 62(2), 5–29. <https://doi.org/10.1111/j.1468-246X.2009.01327.x>
- Bayar, Y. (2018). Financial Sustainability of Pension Systems in the European Union. *European Research Studies*, XVI(3), 46–70.
- Bhattacharjee, N. V., Schumacher, A. E., Aali, A., Abate, Y. H., Abbasgholizadeh, R., Abbasian, M., Abbasi-Kangevari, M., Abbastabar, H., ElHafeez, S. A., Abd-Elsalam, S., Abdollahi, M., Abdollahifar, M.-A., Abdoun, M., Abdullahi, A., Abebe, M., Abebe, S. S., Abiodun, O., Abolhassani, H., Abolmaali, M., ... Vollset, S. E. (2024). Global fertility in 204 countries and territories, 1950–2021, with forecasts to 2100: A comprehensive demographic analysis for the Global Burden of Disease Study 2021. *The Lancet*, 403(10440), 2057–2099. [https://doi.org/10.1016/S0140-6736\(24\)00550-6](https://doi.org/10.1016/S0140-6736(24)00550-6)
- EU commission. (2023). *The impact of demographic change in Europe* (Green Paper on Ageing No. SWD(2021) 282; p. 20). European Commission. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/new-push-european-democracy/impact-demographic-change-europe_en
- Eurostat. (2024, February). Fertility statistics 2022. *Eurostat World Data Statistics Explained*. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Fertility_statistics
- Kahneman, D., & Tversky, A. (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica*, 47(2), 263–291. <https://doi.org/10.2307/1914185>

- Laibson, D. (1997). Golden Eggs and Hyperbolic Discounting. *The Quarterly Journal of Economics*, 112(2), 443–477.
- Mertens, S., Herberz, M., Hahnel, U. J. J., & Brosch, T. (2022). The effectiveness of nudging: A meta-analysis of choice architecture interventions across behavioral domains. *Proceedings of the National Academy of Sciences of the United States of America*, 119(1), e2107346118. <https://doi.org/10.1073/pnas.2107346118>
- Miles, D. (2023). Macroeconomic impacts of changes in life expectancy and fertility. *The Journal of the Economics of Ageing*, 24, 100425. <https://doi.org/10.1016/j.jeoa.2022.100425>
- Modigliani, F. (1986). Life Cycle, Individual Thrift, and the Wealth of Nations. *The American Economic Review*, 76(3), 297–313.
- OECD. (2023). *Pensions at a Glance 2023*. <https://www.oecd-ilibrary.org/content/publication/678055dd-en>
- Oeppen, J., & Vaupel, J. W. (2002). Broken Limits to Life Expectancy. *Science*, 296(5570), 1029–1031. <https://doi.org/10.1126/science.1069675>
- Riley, J. C. (2005). Estimates of Regional and Global Life Expectancy, 1800–2001. *Population and Development Review*, 31(3), 537–543. <https://doi.org/10.1111/j.1728-4457.2005.00083.x>
- World Bank. (2024). *Poverty, Prosperity, and Planet Report 2024: Pathways Out of the Polycrisis*. World Bank. <http://hdl.handle.net/10986/42211>

1

Introduction

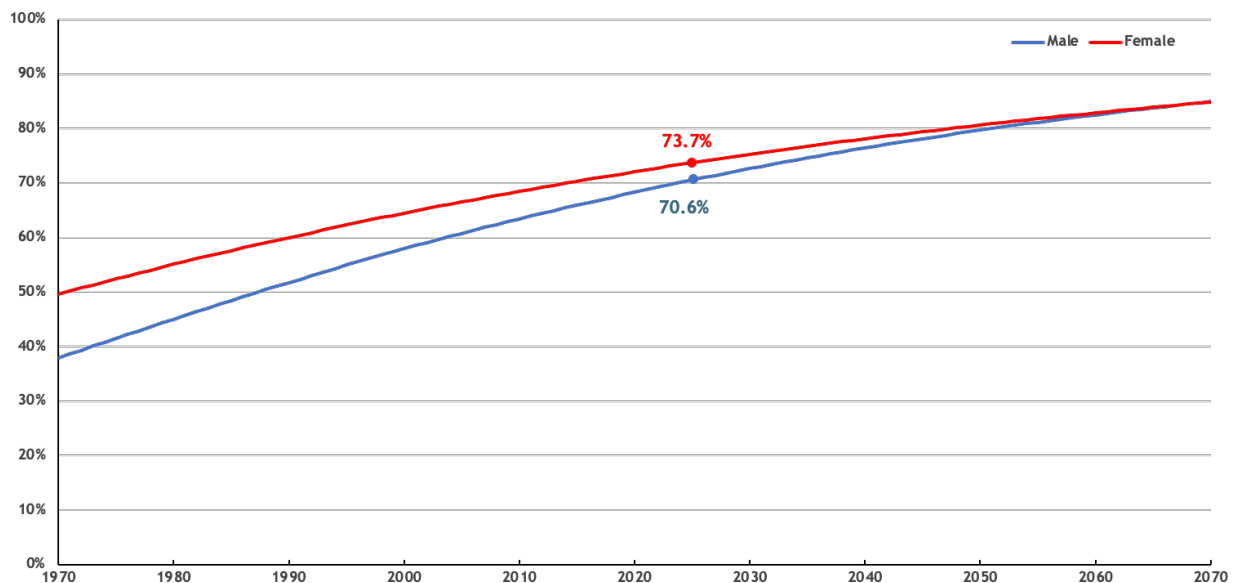
Never in human history has there been a better time to be alive than the 21st century. Average lifespans and educational attainment have hit their highest levels since they were first documented (Dattani et al., 2023; Ritchie et al., 2023). Major lethal infectious diseases like rubella, polio, and smallpox which once plagued humanity have been nearly completely eradicated (Hinman, 1999) and according to the World Bank (2024), extreme poverty now affects only 8.5% of humanity, compared to more than 40% less than a generation ago (Hasell et al., 2022). Yet this unprecedented progress masks a mounting challenge: as populations age rapidly and economies transform fundamentally, sustaining financial security across lifespans becomes increasingly difficult, placing pension systems under historic strain (Miles, 2023; Van Bavel, 2013). While no nation had a life expectancy exceeding 40 years in the early 19th century (Riley, 2005), people in developed nations now live twice as long on average (Oeppen & Vaupel, 2002; Ritchie et al., 2024). Life expectancy has increased by roughly three months per year in recent decades in most developed countries, with several European (EU) nations now reporting life expectancies beyond 84 years (Kontis et al., 2017; OECD, 2024). The pace of this demographic transformation is also accelerating: while it took 70 years for life expectancy at birth to increase from 65 to 75 years in most developed countries, the rise from 75 to 85 years is projected to occur in just half that time (Christensen et al., 2009; Dong et al., 2016; Oeppen & Vaupel, 2002). In Japan alone, the number of centenarians¹ has increased almost a hundred-fold, from approximately 1,000 in 1,981 to over 95,119 as of September 1, 2024 (Japan Ministry of Health, Labor, and Welfare, 2024)

This longevity revolution coincides with a dramatic decline in fertility rates, creating an unprecedented demographic imbalance. By 2050, over three-quarters of countries are expected to have fertility rates below the replacement level of 2.1 children per woman needed for population stability. The European Union is already well below this threshold, with an

¹ The number of people aged 100 or older.

average of only 1.53 children per woman. (Bhattacharjee et al., 2024; Eurostat, 2024). The combination of extending lifespans and declining birth rates has created a fundamental economic challenge: while today 3.7 workers support each retiree across OECD countries, this ratio will shrink to just 2.2 by 2050 (OECD, 2023). This demographic reality, coupled with mounting public debt, persistent low interest rates, and adverse budgetary conditions, has accelerated the erosion of traditional pension guarantees worldwide (Bayar, 2018; Bielecki et al., 2020).

In Belgium, the focus country of this PhD dissertation, these demographic pressures are particularly acute. Belgian newborns in 2025 are projected to have a 72.2% likelihood of living to age 90 (70.6% for men and 73.7% for women). For those born after 2050, this probability is expected to exceed 80% (see Figure 1) (Vandresse, 2021). This dramatic increase in life expectancy, combined with below-replacement level fertility rates, creates an urgent need to reimagine retirement security for future generations.

Figure 1*Belgian Longevity Projections, 1970-2070*

Note. Probability of reaching age 90 by birth cohort and gender in Belgium (1970-2070).

Based on prospective mortality tables from the Belgian Federal Planning Bureau's Demographic Outlook 2020-2070 (Vandresse, 2021). Projections are subject to underlying assumptions and methodological constraints.

The Evolution of European Pension Systems

The structure of pension systems across OECD countries, including Belgium, traditionally rests on a three pillar system: state pensions (Pillar I), occupational pensions (Pillar II), and individual pension products (Pillar III) (Schneider, 2009). Pillar I forms the foundational state safety net, in which a government provides its retirees with a basic income, funded by tax contributions from the current working population. The amount an individual receives in retirement is generally linked to the number of years they contributed to the system during their working life. Pillar II consists of employer-sponsored occupational pensions, which are typically designed to supplement state pensions by providing additional income in retirement. Occupational pensions are often incentivized through tax advantages for both employers and employees, making them an attractive option for securing higher

retirement savings. Contributions are usually made jointly by employers and employees, and the benefits accrued depend on factors such as contribution levels, years of service, and the specific plan design. Pillar III provides voluntary savings options designed to complement state and occupational pensions. These include private retirement accounts, investment funds, real estate, or other long-term financial instruments tailored to individuals' specific financial goals and risk preferences.

Within this framework, recent decades have witnessed a significant transformation in how retirement security is achieved. The most notable shift has been the gradual transfer of retirement planning responsibilities from institutions to individuals, driven by reforms that reduce the generosity of state pensions (Gad-Harf, 2008; Sabelhaus & Volz, 2019). The practical impact of this evolving pension landscape is captured by the net replacement rate: the ratio between total retirement income (sum of Pillar I, II, and III) and pre-retirement earnings. This crucial indicator reveals that across OECD countries, average-income earners can expect their retirement income to drop to just 61.4% of their pre-retirement earnings, with considerable cross-national variation, falling to 40% or below in countries like Poland, Australia, Estonia, Lithuania and more (OECD, 2023). In Belgium, the average net replacement rate stands at 60.9%, meaning retirees must adapt to living on two-thirds of their pre-retirement income, or seek alternative resources through asset liquidation, family support networks, or public assistance programs (OECD, 2019).

The outlook for future generations is even more challenging. Recent projections indicate that over the next three decades, net income replacement ratios will further shrink by 20-25% across OECD countries, requiring younger generations to save approximately 40% more than their parents to achieve equivalent retirement security (EU commission, 2023; OECD, 2023). In light of these budgetary and demographic trends, increased longevity can paradoxically lead to anxiety rather than celebration (Louria, 2005; Vladeck, 2005).

Maintaining living standards will thus require either accumulating more assets or stretching savings over a longer retirement horizon, often resulting in a reduced standard of living. Research consistently demonstrates how deteriorating financial circumstances negatively impact life satisfaction and overall well-being (Clark et al., 2018; Di Tella et al., 2010). This impact is particularly acute for low-income earners (OECD, 2019). Although these individuals generally have higher replacement rates due to progressive tax-pension systems, they still face replacement rates below 50% in several OECD countries (OECD, 2023). This financial reality suggests inadequate pension income even after a full career. Despite the clear need for increased retirement preparation, current saving patterns fall dramatically short of what is required for adequate retirement security. In Belgium, 64% of households are financially vulnerable or unhealthy², with more than half failing to save consistently each month (Deloitte Belgium, 2023). This pattern is not unique to Belgium: across OECD countries, only 49% of working-age households save beyond mandatory systems, while nearly half would need to double their savings rate to maintain their living standard in retirement (OECD, 2023).

Effectively addressing this approaching tsunami of a retirement crisis will, however, require more than individual behavioral change. It is evident that a holistic and fundamental transformation of the pension system, including reforms to product offerings, policies, and support structures will be needed. The scope and complexity of this challenge necessitates coordinated action from all involved stakeholders, as no single intervention or stakeholder group can adequately address the multifaceted nature of pension sustainability.

² Financial health level is determined by a household's (in)ability to maintain a balance across key financial domains: income, expenses, savings, debts, planning, and skills, resulting in difficulties meeting obligations or achieving financial resilience.

Towards Efficient Pillar II and III Pension Decisions in Belgium

Recognizing this need for an integrated approach, in 2019, a consortium of leading Belgian universities (Ghent University, Vrije Universiteit Brussel) and the German Universität Ulm joined forces with an extensive network of industry stakeholders to launch a Strategic Basic Research (SBO) project titled "*Towards Efficient Pillar II and III Pension Decisions in Belgium*" (FWO-SBO S006721N)³. The project brought together a diverse advisory committee representing both the supply and demand sides of pension products and services, including financial sector federations (Febelfin, Assuralia), labor organizations (ABVV), employer representatives (VBO, UNIZO), consumer protection groups (Test-Aankoop), human resources intermediaries (Partena Professional, Liantis), regulatory bodies (FSMA), and public institutions (Federal Planning Bureau, Sigedis).

Previous attempts to address pension adequacy have often focused on either product innovation or regulatory reform in isolation (Benartzi et al., 2011; Fernandes et al., 2014; Lusardi et al., 2011). This SBO project took a more comprehensive approach by acknowledging that even the most innovative financial products and sophisticated investment frameworks cannot achieve their intended impact without understanding and addressing the behavioral barriers that prevent their adoption. While the SBO project's first two work packages addressed product innovation and portfolio optimization respectively, this PhD dissertation focuses on the third work package: understanding and influencing pension-related decision-making through behavioral science.

Financial Decisions Through the Life-Cycle

Throughout one's life cycle, several critical moments emerge where financial decisions have profound long-term implications for retirement security (Cocco & Gomes, 2012;

³ This SBO project was financially supported by the Research Foundation - Flanders (FWO), the funding body for fundamental and strategic research in Flanders, Belgium.

Hubener et al., 2013; Modigliani, 1986). The Life-Cycle Hypothesis, pioneered by Modigliani (1986), suggests that individuals make financial decisions by considering their needs and resources across different life stages, theoretically smoothing consumption over their lifetime. Central to this framework is the idea that individuals accumulate wealth during their working years to support consumption in retirement, aiming to balance periods of earning and dissaving. However, research increasingly shows that actual financial behavior often deviates significantly from these rational predictions (Benartzi & Thaler, 2013; O'Donoghue & Rabin, 2015).

To understand these deviations, it is crucial to examine the pivotal life moments where individuals face significant financial decisions. Through the lens of the Life-Cycle Hypothesis (Modigliani, 1986), several critical transitions emerge. The first pivotal financial moment occurs at the transition to financial adulthood (typically around age 18), when individuals first start making independent financial decisions and develop financial habits that often persist throughout their lives (LeBaron & Kelley, 2021; Vosylis & Klimstra, 2022). A second pivotal moment: labor market entry, where young adults first encounter occupational pension schemes and must decide whether to participate in voluntary retirement savings (Clark et al., 2018; Thaler & Benartzi, 2004). Subsequently, during mid-career, individuals face choices about pension plan participation when changing employers or during career transitions (Choukhmane, 2024; Goda et al., 2020). Finally, as individuals approach labor market exit, they have to deal with complex decisions about asset allocation, decumulation strategies, exemplified by the trade-off between lump sum payments versus annuitization at retirement age (Benartzi et al., 2011; Brown et al., 2008). These transitions represent critical junctures where behavioral barriers can significantly impact long-term financial outcomes.

A Behavioral Lens

At each of these life-cycle transitions, individuals face not only complex financial decisions

but also significant behavioral barriers and cognitive biases that can impede optimal decision-making. The literature identifies several key psychological mechanisms that influence pension decisions. First, status quo bias reflects people's strong preference to maintain their current state, leading to inertia in pension decisions even when change would be beneficial (Kahneman, 2011; Samuelson & Zeckhauser, 1988). Second, present bias fundamentally shapes intertemporal choice (Laibson, 1997). Behavioral research shows that people systematically overvalue immediate outcomes compared to future ones (O'Donoghue & Rabin, 2015; Thaler & Benartzi, 2004). This cognitive bias helps explain why retirement saving intentions often fail to translate into actual saving behavior (Benartzi & Thaler, 2013, p. 200; DellaVigna, 2009). Third, loss aversion fundamentally shapes pension decisions (Xie et al., 2017). People experience the pain of financial losses roughly twice as intensely as they value equivalent gains (Tversky & Kahneman, 1974). This asymmetric sensitivity to losses versus gains leads many to avoid pension contributions, viewing them as immediate financial sacrifices rather than future security gains (Benartzi & Thaler, 2013; Kahneman & Tversky, 1979). Fourth, choice overload and decision paralysis emerge as significant cognitive burdens in retirement decision making (Iyengar & Lepper, 2000; Schwartz, 2004). Research shows that too many choices or complex options often lead to decision paralysis (Iyengar & Lepper, 2000; Scheibehenne et al., 2010). In pension planning, this cognitive overload frequently results in procrastination or complete avoidance of important retirement decisions (Carroll et al., 2009; Goda et al., 2014). Finally, social influences powerfully shape retirement decisions (Cialdini & Trost, 1998; Festinger, 1954). People naturally look to others' behavior when facing complex choices under uncertainty (Asch, 1956; Deutsch & Gerard, 1955). In pension planning, this conformity bias leads individuals to align their saving decisions with perceived peer behavior, often resulting in suboptimal outcomes (Beshears et al., 2015; Duflo & Saez, 2002). However, because saving behavior often occurs in private, the invisibility or lack of

knowledge about peer actions can also play a significant role, leaving individuals to rely on assumptions or social norms rather than accurate information (Beshears et al., 2015). These cognitive biases interact with various context and personal differences, like limited financial literacy, creating significant challenges for pension decision-making across all life stages (Lusardi et al., 2011; Samuelson & Zeckhauser, 1988).

The cumulative impact of these behavioral barriers is substantial: suboptimal decisions at critical moments in life can significantly diminish retirement security through foregone compound interest and missed saving opportunities. A simple illustration: if a 25-year-old delays pension participation by just five years, this person is projected to forfeit up to 25% of his/her potential retirement wealth due to missed compound interest effects (Blake, 2004; Goda et al., 2020). At a societal level, even modest improvements in decision-making could yield dramatic benefits. Conservative back-of-the-napkin estimates suggest that improving pension decision efficiency by a mere 0.5% could generate societal benefits in the order of billions of euros when applied to the total value of Belgian pillar II and III pension reserves, with the greatest potential impact among economically vulnerable groups (Deloitte Belgium, 2023).

To address these behavioral barriers, researchers and policymakers increasingly turn to 'nudging' interventions (Benartzi et al., 2017; Thaler & Sunstein, 2008). These are subtle changes in choice architecture that can guide better decisions without restricting freedom of choice or significantly altering economic incentives (Thaler & Sunstein, 2008). For instance, when employees are automatically enrolled in a workplace pension plan with the option to opt-out, this constitutes a nudge as it subtly changes the choice architecture by leveraging status quo bias to promote retirement savings, while preserving complete freedom of choice (Madrian & Shea, 2001; Thaler & Benartzi, 2004). In contrast, mandating pension

participation or offering substantial tax incentives would not be considered nudges as they either restrict choice or materially alter economic incentives.

Nudge interventions are grounded in dual process theory, a cognitive framework whose origins date to psychological research of the 1970s (Evans, 2008; Stanovich & West, 2000; Wason & Evans, 1974). This theory suggests that decision-making involves two distinct metaphorical modes of thinking: System 1 and System 2 (Kahneman, 2011). While various dual-processing theories exist, they all recognize these two separate processing modes, with System 1 representing fast, automatic, and intuitive thinking, and System 2 enabling more deliberative, conscious processing (De Neys, 2006; Sloman, 1996; Smith & DeCoster, 2000).

System 1 is influenced by dominant cues in the environment, operating through heuristics and pre-existing beliefs without deep analysis (Gilovich et al., 2002; Tversky & Kahneman, 1974). This automatic processing makes it particularly susceptible to behavioral biases but also allows for rapid decision-making with minimal cognitive effort (Evans, 2008; Stanovich, 2009). In contrast, System 2 requires more cognitive resources and is activated when we engage in critical thinking or complex problem-solving, allowing for more rational and informed decisions (Evans & Over, 1996; Kahneman & Frederick, 2002). However, due to its energy-consuming nature and limited cognitive bandwidth (Baumeister et al., 1998; Mullainathan & Shafir, 2013), we often default to System 1's automatic processing, which can sometimes result in impulsive or biased behavior, even when a more thoughtful response might be appropriate. Importantly, behavior can result from either system or a combination of both (Favela & van Rooij, 2019; Thompson et al., 2011).

While dual process theory has been influential in behavioral science and nudge interventions, recent scholarship has challenged the strict dichotomy between System 1 and System 2 thinking. Rather than two distinct systems, some researchers argue for more

nuanced conceptualizations that view cognitive processing along a continuum (Augusto, 2024; Melnikoff & Bargh, 2018; Osman, 2020). De Neys (2021) suggests that what traditionally was thought to require deliberate System 2 processing can also occur intuitively, indicating more overlap between the systems than originally assumed. Additionally, recent neuroimaging evidence points to shared neural networks between intuitive and deliberative processing, questioning the biological basis for strictly separate systems (Bago & De Neys, 2019; Voudouri et al., 2024). Some scholars have proposed alternative frameworks altogether, such as the cognitive continuum theory (Hammond, 1996), the dynamic graded continuum (Cleeremans & Jimenez, 2002) or unified theoretical accounts emphasizing the dynamic interplay between different processing types (Kruglanski & Gigerenzer, 2011; Mugg, 2018). The inferential framework proposed by Van Dessel et al. (2022) suggests that all behavior results from context-dependent inferences about goals and available actions, regardless of processing speed or effort. These evolving theoretical perspectives do not necessarily invalidate dual process theory's practical applications in choice architecture, but they do suggest that the underlying cognitive mechanisms may be more nuanced, complex and interconnected than initially conceptualized (De Neys, 2023; Voudouri et al., 2024).

Drawing on these theoretical insights, whether viewed as distinct systems or more fluid cognitive processes, choice architects deliberately intervene in the choice environment to work with, rather than against, the way people naturally process information and make decisions (Johnson et al., 2012; Thaler & Sunstein, 2008). While traditional approaches often focus on engaging deliberative thinking through education or rational argumentation (Fernandes et al., 2014), behavioral interventions can be more effective by working with automatic or intuitive responses (Benartzi & Thaler, 2013; Sunstein, 2014). By understanding and working with established cognitive patterns and decision-making tendencies (DellaVigna, 2009; Loewenstein et al., 2015), subtle changes in choice architecture can significantly impact

behavior without restricting freedom of choice or altering economic incentives, the essence of nudging (Münscher et al., 2016; Szaszi et al., 2018).

While acknowledging the complex and nuanced nature of cognitive processing debates, for clarity and consistency with the dominant literature in behavioral interventions and choice architecture, we will employ the System 1 and System 2 terminology throughout this PhD dissertation (Evans & Stanovich, 2013; Kahneman, 2011; Thaler & Sunstein, 2008). This choice reflects both the framework's practical utility in explaining behavioral interventions and its continued widespread use in applied behavioral science research (Münscher, 2024; Szaszi et al., 2018).

The success of nudging interventions stems from their ability to work with, rather than against, this dual-system architecture. Instead of requiring constant engagement of effortful System 2 thinking, effective nudges leverage System 1's automatic responses by modifying choice environments to make better decisions easier and more intuitive. For example, automatic enrollment in pension plans succeeds because it aligns System 1's tendency toward inaction (status quo bias) with beneficial long-term outcomes, while still preserving System 2's ability to override this default through conscious deliberation (Johnson et al., 2012; R. H. Thaler & Sunstein, 2008). Understanding this dual-system framework helps explain why subtle changes in choice architecture can significantly impact behavior without restricting freedom of choice or altering economic incentives.

Recent large-scale studies have sparked an important academic debate about the statistical effectiveness of such behavioral nudges. A comprehensive meta-analysis by Mertens et al. (2022), examining 447 nudge effect sizes from 212 experiments involving over 2 million participants, found an average effect size of $d = 0.43$. Subsequent re-analyses adjusting for publication bias suggested more modest effects, or even claiming no effects of (Bakdash & Marusich, 2022; Maier et al., 2022).

These statistical debates about nudge effectiveness occur within a broader theoretical discussion about individual (i-frame) versus systemic (s-frame) approaches, where some argue for greater focus on systemic change (Chater & Loewenstein, 2022), though others caution against viewing individual and systemic approaches as competing rather than complementary frameworks (Hallsworth, 2023). However, amidst these debates, one crucial insight is often overlooked: the true value of nudging lies not in the magnitude of its statistical effects in isolation, but rather in its exceptional cost-effectiveness compared to traditional policy instruments (Benartzi et al., 2017).

In a landmark study, Benartzi et al. (2017) demonstrate that when implementation costs are considered, behavioral interventions consistently outperform conventional policy approaches across multiple domains. For example, in college enrollment, nudges yield 1.53 additional enrollments per \$1,000 spent compared to 0.0351 for traditional monetary incentives (Bettinger et al., 2012; Dynarski, 2003). In the domain of energy conservation, nudges achieve 27.3 kWh in energy savings per \$1 spent versus just 3.41 kWh for standard incentive programs (Allcott, 2011; Ito, 2015). This cost-effectiveness advantage becomes particularly impactful in pension policy, where even modest behavioral changes, when scaled across large populations and compounded over time, can yield substantial societal welfare gains. A simple automatic occupational pension enrollment nudge generates \$100 in additional savings per \$1 spent on implementation, compared to just \$2.77 for tax incentives and \$14.58 for educational programs (Chetty et al., 2014). Rather than focusing solely on absolute effect sizes, the key consideration for policy makers should be the relative return on investment when choosing between different intervention strategies.

While initial research focused on identifying and testing individual nudges, recent efforts have aimed to systematically categorize nudging interventions to better understand their mechanisms and relative effectiveness (Sunstein, 2014; Szaszi et al., 2018). Building on

Sunstein's (2014) comprehensive catalog of ten distinct nudges, Mertens et al. (2022) developed a unifying framework that further categorizes behavioral interventions into three broad categories: decision structure (DS), decision assistance (DA), and decision information (DI). This categorization provides a systematic lens through which to understand how different types of nudges operate and their relative effectiveness across various domains.

Decision Structure (DS) Interventions

Decision Structure (DS) interventions, which address our limited capacity to evaluate and compare choice options, consistently show the strongest effects on behavior change ($d = 0.54$) (Mertens et al., 2022). These interventions include changing default options, altering the range or composition of available choices, modifying choice consequences, or adjusting the effort required to select different options (Johnson et al., 2012; Münscher et al., 2016). In the finance domain specifically, DS interventions demonstrate a robust effect size of $d = 0.33$, making them particularly valuable for improving financial decision-making (Mertens et al., 2022).

DS interventions modify choice environments through four key mechanisms: (1) changing choice defaults to address behavioral inertia and loss aversion, such as automatic enrollment in retirement savings plans (Madrian & Shea, 2001); (2) adjusting option-related effort by modifying physical or financial friction in the decision process (Johnson et al., 2012); (3) changing the range or composition of options to facilitate easier evaluation, like restructuring how investment choices are presented (Iyengar & Kamenica, 2010); and (4) modifying option consequences through adapted incentives or framing to address present bias and loss aversion (Hershfield et al., 2020).

The effectiveness of DS interventions may be attributed to their ability to work with, rather than against, people's cognitive limitations. By changing the environment in which

decisions are made, these interventions can guide behavior without requiring extensive cognitive effort from the decision-maker (Kahneman, 2011; R. H. Thaler & Sunstein, 2008).

Decision Assistance (DA) Interventions

Decision Assistance (DA) interventions, which aid individuals in following through with their intentions and which facilitate self-regulation, show a moderate but consistent effect ($d = 0.28$) on behavior change (Mertens et al., 2022). These interventions primarily address the well-documented gap between intentions and actions, often referred to as the 'intention-behavior gap' (Sheeran & Webb, 2016). In the financial domain specifically, DA interventions demonstrate an effect size of $d = 0.21$, suggesting that helping individuals follow through on their financial intentions can meaningfully impact decision outcomes (Mertens et al., 2022).

DA interventions operate through two primary mechanisms: (1) reminders to increase the attentional salience of desirable behavior and overcome information overload, such as timely notifications about saving goals (Fernandes et al., 2014; Karlan et al., 2016); and (2) commitment facilitation to encourage self or public commitment, exemplified by commitment saving accounts which increased savings balances by 81% by allowing individuals to restrict access to funds until reaching self-set goals (Ashraf et al., 2006; Bryan et al., 2010).

The effectiveness of DA interventions stems from their ability to bridge the gap between System 1's automatic responses and System 2's deliberative planning (Kahneman, 2011). By creating explicit plans or commitments in advance, these interventions help individuals overcome limitations in attention and self-control that often hinder optimal decision-making (R. H. Thaler & Sunstein, 2008). Furthermore, DA interventions often leverage psychological principles such as cognitive dissonance, where the discomfort of acting inconsistently with prior commitments can motivate behavior change (Festinger, 1957).

Decision Information (DI) Interventions

Decision Information (DI) interventions, which modify how information is presented and processed, demonstrate a significant impact on behavior change ($d = 0.34$) (Mertens et al., 2022). In financial contexts, these interventions show an effect size of $d = 0.23$, highlighting their potential to influence financial decision-making through improved information presentation and social influence (Mertens et al., 2022). Unlike DS interventions that modify choice architecture or DA interventions that facilitate follow-through, DI interventions focus on making relevant information more salient, understandable, or personally relevant to decision-makers.

DI interventions address limited access to decision-relevant information through three key mechanisms: (1) translating information to facilitate processing of available information and shift decision-maker's perspective (Münscher et al., 2016); (2) making information visible by providing access to relevant information, such as simplified disclosure formats and color-coded risk indicators in investment decisions (Bateman et al., 2016; Vlaev et al., 2009); and (3) providing social reference points to reduce situational ambiguity, as demonstrated in retirement saving decisions where peer information influences participation rates (Bursztyn et al., 2014; Duflo & Saez, 2002).

The effectiveness of DI interventions stems from their ability to address two fundamental challenges in decision-making: information processing limitations and social influence. By making relevant information more accessible and leveraging social comparison tendencies, these interventions can help bridge the gap between available information and its effective use in decision-making (Johnson et al., 2012; Kahneman, 2011). However, recent research suggests that the effectiveness of DI interventions can vary significantly based on context and implementation (DellaVigna & Linos, 2022; Hummel & Maedche, 2019). For instance, while social reference information generally promotes conformity (Cialdini & Trost,

1998), it can sometimes backfire if the reference point seems unattainable or irrelevant to the decision-maker (Beshears et al., 2015; Dur et al., 2021). Similarly, the effectiveness of information framing depends heavily on the target audience's financial literacy and cognitive resources (Fernandes et al., 2014; Lusardi & Mitchell, 2011). This context-dependency underscores the importance of carefully calibrating DI interventions to specific decision environments and target populations (Szaszi et al., 2022).

Research Gap

While behavioral interventions have shown promise in improving financial decision-making, critical gaps remain in understanding their effectiveness within pension contexts, particularly in European welfare systems.

First, although substantial research has explored individual behavioral interventions, particularly in U.S. contexts, there is limited systematic evidence comparing distinct types of interventions (DS/DA/DI) within European welfare systems. Additionally, the question of how these interventions influence pension-saving decisions across the lifespan remains underexplored, making it difficult to identify which strategies are most effective at different stages of retirement planning.

Second, existing studies predominantly focus on binary outcomes, such as enrollment decisions (e.g., enroll/don't enroll), neglecting the broader question of how behavioral interventions affect the magnitude of financial commitments. This leaves an important gap in understanding whether such interventions can encourage not only participation but also higher contribution levels, which are vital for addressing pension savings shortfalls.

Third, the interplay between different types of behavioral interventions remains poorly understood. Specifically, little is known about the potential synergies or interference effects that arise when combining DS, DA, and DI interventions. This lack of insight limits

the ability to design comprehensive intervention strategies that account for their combined impact on retirement savings decisions.

Fourth, much of the existing evidence on behavioral interventions originates from U.S. settings, which are characterized by weaker social safety nets and lower administrative friction. In contrast, European pension systems, with their strong welfare states and unique institutional arrangements, present distinct challenges and opportunities. For instance, the success of enrollment defaults observed in the U.S. may not directly translate to European contexts, where administrative barriers and robust safety nets influence decision-making in different ways.

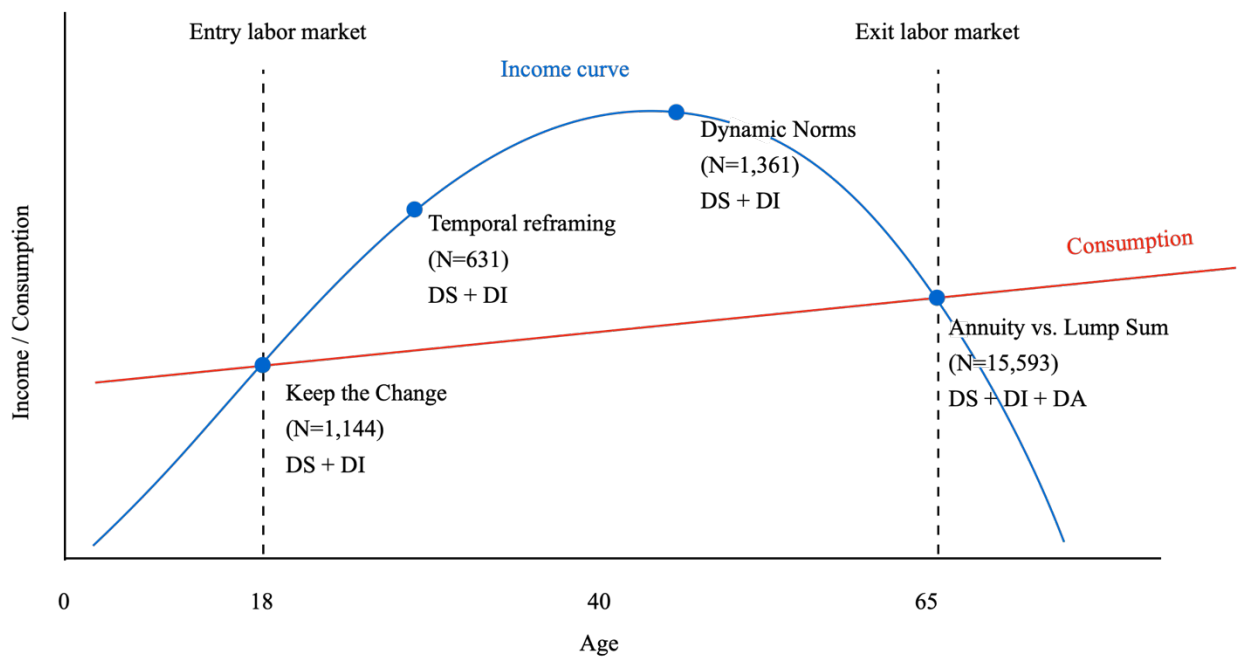
Finally, behavioral interventions are often grounded in traditional dual-process theories, which emphasize the distinction between intuitive (System 1) and deliberative (System 2) thinking. However, recent theoretical advancements suggest that more complex cognitive mechanisms may be at play, particularly in pension decisions that require a balance of intuition and deliberation. There is limited research on how different intervention types (DS/DA/ DI) align with these nuanced cognitive processes. For example, some interventions may activate goal-directed inferential processes (Van Dessel et al., 2022), while others might leverage the dynamic interplay between intuitive and deliberative thinking (De Neys, 2023). Without a deeper understanding of these mechanisms, it is challenging to design interventions that are both effective and theoretically grounded. While we will not focus the studies in this PhD dissertation on empirically testing the underlying cognitive mechanisms (e.g., System 1 vs. System 2) directly, we adopt this nuanced framework as a conceptual lens to interpret our findings and to identify promising directions for future research on the cognitive underpinnings of behavioral interventions.

This PhD dissertation aims to address these gaps through four empirical studies that systematically examine different combinations of behavioral interventions across key life-

cycle transitions. By employing carefully designed vignette studies with large samples, we can isolate the effects of specific intervention types while controlling for contextual factors. Moreover, our use of continuous rather than binary outcome measures in several studies provides novel insights into how behavioral interventions affect not just participation decisions but also contribution levels. Finally, by situating our research within the Belgian pension context, we extend understanding of how behavioral interventions operate within European welfare states, where different institutional arrangements may moderate their effectiveness.

Research Overview: A Life-Cycle Approach to Pension Decisions

Throughout the life-cycle, individuals face critical financial decision points where behavioral barriers can significantly impact long-term retirement security (Shefrin & Thaler, 1988). While behavioral interventions show promise in improving financial decisions, their effectiveness varies considerably across different life stages and contexts. This PhD dissertation examines how different combinations of DS, DA, and DI interventions address specific behavioral barriers at key life transitions in ones life-cycle, with each empirical chapter employing carefully designed vignette studies to test behavioral interventions in controlled settings. A visual representation of how these studies map onto critical financial decision points throughout the life-cycle is presented in Figure 2.

Figure 2*Research Overview: A Life-Cycle Approach to Pension Decisions*

Note. The figure maps the four empirical studies in this PhD (indicated with blue dots) onto the life-cycle income model (Modigliani, 1986). The income curve represents average earnings over the life span, while the consumption line represents spending patterns.

Behavioral intervention type studied in each chapter is indicated: DS (Decision Structure), DA (Decision Assistance), and DI (Decision Information). Each study investigates specific combinations of interventions at critical financial decision points: initial saving decisions (Chapter 2: Keep the Change, $N = 1,144$), early contribution choices (Chapter 3: Temporal Reframing, $N = 631$), occupational pension enrollment (Chapter 4: Dynamic Norms, $N = 1,361$), and retirement decumulation decisions (Chapter 5: Annuity vs. Lump Sum, $N = 15,593$).

Chapter 2: Keep the Change

Our first empirical chapter ($N = 1,144$) investigates the earliest stage of the financial life-cycle, when young adults transition to financial independence. While research has established the importance of early saving habits (LeBaron & Kelley, 2021; Vosylis & Klimstra, 2022), little is known about how innovative fintech features might help overcome

the psychological barriers to starting investment habits. This study examines how behavioral interventions can encourage young adults to begin micro-investing. Through a vignette experiment, we present hypothetical roundup investing scenarios that automatically invest spare change from daily transactions. We test two complementary interventions: set-and-forget defaults (DS) and dynamic social norms (DI). These interventions aim to overcome two key barriers: present bias that favors immediate spending over investing, and complexity aversion that makes traditional investing appear overwhelming. Theoretically, comparing these distinct intervention types can allow us to examine how defaults might facilitate goal-directed inferential processes (Van Dessel et al., 2022), while dynamic norms engage both automatic conformity responses and deliberative social evaluation (De Neys, 2023), advancing our understanding beyond traditional dual-process assumptions.

Chapter 3: Temporal Reframing

The second empirical chapter ($N = 631$) builds on these early-career insights by examining how temporal framing influences saving decisions. Temporal framing leverages mental accounting principles; people's tendency to evaluate financial decisions differently based on how they are categorized and presented (Thaler, 1985). Building on Gourville's (1998) pennies-a-day effect, we compare how framing identical pension contributions as daily, weekly, or monthly amounts affects contribution levels. While Hershfield et al. (2020) showed daily framing could boost retirement plan participation from 22% to 79%, their binary enrollment measure couldn't capture how different temporal frames affect contribution amounts. Our study introduces a continuous measure to examine how temporal framing influences not just whether people save, but how much they commit. Daily frames (e.g., "€2 per day" versus €60 per month) counter three psychological barriers: loss aversion through smaller nominal values, categorization bias by integrating with routine mental budgets, and temporal discounting by feeling more concrete and immediate. By examining these

mechanisms' influence on contribution magnitude rather than just enrollment, this study informs choice architecture design to increase retirement savings. Additionally, by comparing how different temporal frames affect continuous contribution decisions, we can examine whether mental accounting effects operate purely through intuitive System 1 processes, or whether they might engage more deliberative goal-directed inferential processes when people actively consider contribution amounts (Van Dessel et al., 2022), advancing theoretical understanding of how temporal reframing interventions influence financial decision-making.

Chapter 4: Dynamic Norms and Defaults

Our third empirical chapter ($N = 1,361$) advances understanding of mid-career pension decisions by examining how defaults and social norms operate in European pension contexts. Default enrollment leverages status quo bias and inertia to overcome decision paralysis, while dynamic social norms counter conformity bias by signaling growing peer adoption. While opt-out defaults have dramatically increased U.S. pension participation by reducing procrastination and complexity barriers (Madrian & Shea, 2001), their effectiveness in strong welfare states, where state pensions create a false sense of security and administrative friction increases opt-out costs, remains understudied. Through vignette-based employment scenarios, this study tests whether opt-out defaults (DS) retain their power when combined with dynamic social information (DI) in Belgian occupational pension decisions, where robust social security might dampen both interventions' impact. Theoretically, examining how defaults interact with dynamic social information in high-friction environments provides insights into whether these interventions operate through independent or interactive cognitive pathways. This advances our understanding beyond traditional dual-process assumptions by exploring whether increased administrative friction might prompt more deliberative processing (De Neys, 2023) or whether dynamic norms could enhance or disrupt the automatic goal-directed inferences typically facilitated by defaults (Van Dessel et al., 2022).

Chapter 5: Annuity vs. Lump Sum Mega-Study

The fourth empirical chapter ($N = 15,593$) addresses one of the most complex financial decisions individuals face during the life-cycle: pension decumulation. Despite extensive research on annuitization preferences (Benartzi et al., 2011), the effectiveness of behavioral interventions in supporting these decisions remains unclear. Our mega-study tests three distinct intervention categories targeting different psychological barriers: Decision Structure interventions (DS: defaults and choice format) counter status quo bias and choice overload; Decision Assistance interventions (DA: pre-commitment and implementation planning) address present bias and intention-action gaps; and Decision Information interventions (DI: social norms and risk labels) combat conformity bias and complexity aversion. Through 24 experimental conditions combining these interventions ($3 \times 2 \times 2 \times 2$ design), we systematically compare their independent and interactive effects on annuitization. This comprehensive approach not only allows direct comparison of intervention effectiveness but also provides sufficient statistical power to detect even small effects, addressing recent concerns about publication bias and replicability in behavioral science. Theoretically, this mega-study design enables us to examine how different intervention types might engage distinct cognitive processes beyond simple System 1/System 2 distinctions. By systematically comparing DS, DA, and DI interventions both independently and in combination, we can indirectly investigate whether these nudges operate through separate cognitive pathways (De Neys, 2023) or work together to facilitate more complex goal-directed inferential processes (Van Dessel et al., 2022), advancing our understanding of how different choice architecture tools influence complex financial decisions.

References

- Allcott, H. (2011). Social norms and energy conservation. *Journal of Public Economics*, 95(9), 1082-1095. <https://doi.org/10.1016/j.jpubeco.2011.03.003>
- Asch, S. E. (1956). Studies of independence and conformity: I. A minority of one against a unanimous majority. *Psychological Monographs: General and Applied*, 70(9), 1-70. <https://doi.org/10.1037/h0093718>
- Ashraf, N., Karlan, D. S., & Yin, W. (2006). *Household Decision Making and Savings Impacts: Further Evidence from a Commitment Savings Product in the Philippines* (SSRN Scholarly Paper No. 912771). <https://doi.org/10.2139/ssrn.912771>
- Augusto, R. (2024). Two Kinds of Process or Two Kinds of Processing? Disambiguating Dual-Process Theories. *Review of Philosophy and Psychology*, 15(1), 277-298. <https://doi.org/10.1007/s13164-023-00673-1>
- Bago, B., & De Neys, W. (2019). The intuitive greater good: Testing the corrective dual process model of moral cognition. *Journal of Experimental Psychology: General*, 148(10), 1782-1801. <https://doi.org/10.1037/xge0000533>
- Bakdash, J. Z., & Marusich, L. R. (2022). Left-truncated effects and overestimated meta-analytic means. *Proceedings of the National Academy of Sciences*, 119(31), e2203616119. <https://doi.org/10.1073/pnas.2203616119>
- Bateman, H., Eckert, C., Geweke, J., Louviere, J., Satchell, S., & Thorp, S. (2016). Risk Presentation and Portfolio Choice. *Review of Finance*, 20(1), 201-229.
- Baumeister, R. F., Bratslavsky, E., Muraven, M., & Tice, D. M. (1998). Ego depletion: Is the active self a limited resource? *Journal of Personality and Social Psychology*, 74(5), 1252-1265. <https://doi.org/10.1037/0022-3514.74.5.1252>
- Bayar, Y. (2018). Financial Sustainability of Pension Systems in the European Union. *European Research Studies*, XVI(3), 46-70.

- Benartzi, S., Beshears, J., Milkman, K. L., Sunstein, C. R., Thaler, R. H., Shankar, M., Tucker-Ray, W., Congdon, W. J., & Galing, S. (2017). Should Governments Invest More in Nudging? *PSYCHOLOGICAL SCIENCE*, 28(8), 1041-1055.
<https://doi.org/10.1177/0956797617702501>
- Benartzi, S., Previtiero, A., & Thaler, R. H. (2011). Annuity Puzzles. *Journal of Economic Perspectives*, 25(4), 143-164. <https://doi.org/10.1257/jep.25.4.143>
- Benartzi, S., & Thaler, R. H. (2013). Behavioral Economics and the Retirement Savings Crisis. *SCIENCE*, 339(6124), 1152-1153. <https://doi.org/10.1126/science.1231320>
- Beshears, J., Choi, J. J., Laibson, D., Madrian, B. C., & Milkman, K. L. (2015). The Effect of Providing Peer Information on Retirement Savings Decisions. *The Journal of Finance*, 70(3), 1161-1201. <https://doi.org/10.1111/jofi.12258>
- Bettinger, E. P., Long, B. T., Oreopoulos, P., & Sanbonmatsu, L. (2012). The Role of Application Assistance and Information in College Decisions: Results from the H&R Block Fafsa Experiment*. *The Quarterly Journal of Economics*, 127(3), 1205-1242.
<https://doi.org/10.1093/qje/qjs017>
- Bhattacharjee, N. V., Schumacher, A. E., Aali, A., Abate, Y. H., Abbasgholizadeh, R., Abbasian, M., Abbasi-Kangevari, M., Abbastabar, H., ElHafeez, S. A., Abd-Elsalam, S., Abdollahi, M., Abdollahifar, M.-A., Abdoun, M., Abdullahi, A., Abebe, M., Abebe, S. S., Abiodun, O., Abolhassani, H., Abolmaali, M., ... Vollset, S. E. (2024). Global fertility in 204 countries and territories, 1950–2021, with forecasts to 2100: A comprehensive demographic analysis for the Global Burden of Disease Study 2021. *The Lancet*, 403(10440), 2057-2099. [https://doi.org/10.1016/S0140-6736\(24\)00550-6](https://doi.org/10.1016/S0140-6736(24)00550-6)
- Bielecki, M., Brzoza-Brzezina, M., & Kolasa, M. (2020). Demographics and the natural interest rate in the euro area. *European Economic Review*, 129, 103535.
<https://doi.org/10.1016/j.euroecorev.2020.103535>

Blake, D. (2004). The impact of wealth on consumption and retirement behaviour in the UK.

Applied Financial Economics, 14(8), 555-576.

<https://doi.org/10.1080/0960310042000233863>

Brown, J. R., Kling, J. R., Mullainathan, S., & Wrobel, M. V. (2008). Why Don't People Insure Late-Life Consumption? A Framing Explanation of the Under-Annuitization Puzzle. *American Economic Review*, 98(2), 304-309.

<https://doi.org/10.1257/aer.98.2.304>

Bryan, G., Karlan, D., & Nelson, S. (2010). Commitment Devices. *Annual Review of Economics*, 2(Volume 2, 2010), 671-698.

<https://doi.org/10.1146/annurev.economics.102308.124324>

Bursztyn, L., Ederer, F., Ferman, B., & Yuchtman, N. (2014). Understanding Mechanisms Underlying Peer Effects: Evidence From a Field Experiment on Financial Decisions. *Econometrica*, 82(4), 1273-1301. <https://doi.org/10.3982/ECTA11991>

Carroll, G. D., Choi, J. J., Laibson, D., Madrian, B. C., & Metrick, A. (2009). Optimal Defaults and Active Decisions*. *The Quarterly Journal of Economics*, 124(4), 1639-1674. <https://doi.org/10.1162/qjec.2009.124.4.1639>

Chater, N., & Loewenstein, G. (2022). *The i-Frame and the s-Frame: How Focusing on Individual-Level Solutions Has Led Behavioral Public Policy Astray* (SSRN Scholarly Paper No. 4046264). Social Science Research Network.

<https://doi.org/10.2139/ssrn.4046264>

Chetty, R., Friedman, J. N., Leth-Petersen, S., Nielsen, T. H., & Olsen, T. (2014). Active Vs. Passive Decisions and Crowd-Out in Retirement Savings Accounts: Evidence from Denmark. *The Quarterly Journal of Economics*, 129(3), 1141-1220.

Choukhmane, T. (2024). *Default Options and Retirement Saving Dynamics*.

<https://tahachoukhmane.com/wp-content/uploads/2024/04/Choukhmane-2024-Default-options.pdf>

Christensen, K., Doblhammer, G., Rau, R., & Vaupel, J. W. (2009). Ageing populations: The challenges ahead. *The Lancet*, 374(9696), 1196-1208. [https://doi.org/10.1016/S0140-6736\(09\)61460-4](https://doi.org/10.1016/S0140-6736(09)61460-4)

Cialdini, R. B., & Trost, M. R. (1998). Social influence: Social norms, conformity and compliance. In *The handbook of social psychology, Vols. 1-2, 4th ed* (pp. 151-192). McGraw-Hill.

Clark, A. E., Flèche, S., Layard, R., Powdthavee, N., & Ward, G. (2018). *The Origins of Happiness: The Science of Well-Being over the Life Course* (NED-New edition). Princeton University Press. <https://doi.org/10.2307/j.ctvd58t1t>

Cleeremans, A., & Jimenez, L. (2002). Implicit Learning and Consciousness: A Graded, Dynamic Perspective. In R. M. French & A. Cleeremans (Red.), *Implicit Learning and Consciousness: An Empirical*. Psychology Press.

Cocco, J. F., & Gomes, F. J. (2012). Longevity risk, retirement savings, and financial innovation. *Journal of Financial Economics*, 103(3), 507-529. <https://doi.org/10.1016/j.jfineco.2011.10.002>

De Neys, W. (2006). Dual processing in reasoning: Two systems but one reasoner. *Psychological Science*, 17(5), 428-433. <https://doi.org/10.1111/j.1467-9280.2006.01723.x>

De Neys, W. (2021). On Dual- and Single-Process Models of Thinking. *Perspectives on Psychological Science*, 16(6), 1412-1427. <https://doi.org/10.1177/1745691620964172>

De Neys, W. (2023). Further advancing fast-and-slow theorizing. *Behavioral and Brain Sciences*, 46, e146. <https://doi.org/10.1017/S0140525X23000559>

- DellaVigna, S. (2009). Psychology and Economics: Evidence from the Field. *Journal of Economic Literature*, 47(2), 315-372. <https://doi.org/10.1257/jel.47.2.315>
- DellaVigna, S., & Linos, E. (2022). RCTs to Scale: Comprehensive Evidence From Two Nudge Units. *Econometrica*, 90(1), 81-116. <https://doi.org/10.3982/ECTA18709>
- Deloitte Belgium. (2023). *Financial health in Belgium*.
<https://www.deloitte.com/be/en/Industries/financial-services/research/financial-health.html>
- Deutsch, M., & Gerard, H. B. (1955). A study of normative and informational social influences upon individual judgement. *Journal of Abnormal Psychology*, 51(3), 629-636. <https://doi.org/10.1037/h0046408>
- Di Tella, R., Haiken-De New, J., & MacCulloch, R. (2010). Happiness adaptation to income and to status in an individual panel. *Journal of Economic Behavior & Organization*, 76(3), 834-852. <https://doi.org/10.1016/j.jebo.2010.09.016>
- Dong, X., Milholland, B., & Vijg, J. (2016). Evidence for a limit to human lifespan. *Nature*, 538(7624), 257-259. <https://doi.org/10.1038/nature19793>
- Duflo, E., & Saez, E. (2002). Participation and investment decisions in a retirement plan: The influence of colleagues' choices. *Journal of Public Economics*, 85(1), 121-148.
- Dur, R., Fleming, D., van Garderen, M., & van Lent, M. (2021). A social norm nudge to save more: A field experiment at a retail bank. *Journal of Public Economics*, 200, 104443. <https://doi.org/10.1016/j.jpubeco.2021.104443>
- Dynarski, S. M. (2003). Does Aid Matter? Measuring the Effect of Student Aid on College Attendance and Completion. *The American Economic Review*, 93(1), 279-288.
- EU commission. (2023). *The impact of demographic change in Europe* (Green Paper on Ageing No. SWD(2021) 282; p. 20). European Commission.

https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/new-push-european-democracy/impact-demographic-change-europe_en

Eurostat. (2024, februari). Fertility statistics 2022. *Eurostat World Data Statistics Explained*.

https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Fertility_statistics

Evans, J. (2008). Dual-Processing Accounts of Reasoning, Judgment, and Social Cognition.

Annual Review of Psychology, 59(1), 255-278.

<https://doi.org/10.1146/annurev.psych.59.103006.093629>

Evans, J., & Over, D. (1996). *Rationality and reasoning* (pp. xi, 179). Psychology/Erlbaum (Uk) Taylor & Fr.

Evans, J., & Stanovich, K. (2013). Dual-Process Theories of Higher Cognition: Advancing the Debate. *Perspectives on Psychological Science*, 8(3), 223-241.

<https://doi.org/10.1177/1745691612460685>

Favela, L. H., & van Rooij, M. M. J. W. (2019). Reasoning across continuous landscapes: A nonlinear dynamical systems theory approach to reasoning. *Cognitive Systems Research*, 54, 189-198. <https://doi.org/10.1016/j.cogsys.2018.12.013>

Research, 54, 189-198. <https://doi.org/10.1016/j.cogsys.2018.12.013>

Fernandes, D., Lynch, J. G., & Netemeyer, R. G. (2014). Financial Literacy, Financial Education, and Downstream Financial Behaviors. *Management Science*, 60(8), 1861-1883.

Festinger, L. (1954). *A Theory of Social Comparison Processes*. 7(2), 117-140.

Festinger, L. (1957). *A theory of cognitive dissonance* (pp. xi, 291). Stanford University Press.

Gad-Harf, J. (2008). The Decline of Traditional Pensions, the Impact of the Pension Protection Act of 2006, and the Future of America's Defined-Benefit Pension System. *Chicago-Kent Law Review*, 83(3), 1409.

- Gilovich, T., Griffin, D., & Kahneman, D. (Eds.). (2002). *Heuristics and Biases: The Psychology of Intuitive Judgment*. Cambridge University Press.
<https://doi.org/10.1017/CBO9780511808098>
- Goda, G. S., Levy, M. R., Manchester, C. F., Sojourner, A., & Tasoff, J. (2020). Who is a passive saver under opt-in and auto-enrollment? *Journal of Economic Behavior & Organization*, 173, 301-321. <https://doi.org/10.1016/j.jebo.2019.08.026>
- Goda, G. S., Manchester, C. F., & Sojourner, A. J. (2014). What will my account really be worth? Experimental evidence on how retirement income projections affect saving. *Journal of Public Economics*, 119, 80-92.
<https://doi.org/10.1016/j.jpubeco.2014.08.005>
- Gourville, J. T. (1998). Pennies-a-Day: The Effect of Temporal Reframing on Transaction Evaluation. *Journal of Consumer Research*, 24(4), 395-408.
<https://doi.org/10.1086/209517>
- Hallsworth, M. (2023). *Misconceptions about the Practice of Behavioral Public Policy* (SSRN Scholarly Paper No. 4328659). Social Science Research Network.
<https://doi.org/10.2139/ssrn.4328659>
- Hammond, K. R. (1996). *Human judgement and social policy: Irreducible uncertainty, inevitable error, unavoidable injustice* (pp. xi, 436). Oxford University Press.
- Hershfield, H. E., Shu, S., & Benartzi, S. (2020). Temporal Reframing and Participation in a Savings Program: A Field Experiment. *Marketing Science*, 39(6), 1039-1051.
<https://doi.org/10.1287/mksc.2019.1177>
- Hubener, A., Maurer, R., & Mitchell, O. S. (2013). *How Family Status and Social Security Claiming Options Shape Optimal Life Cycle Portfolios* (SSRN Scholarly Paper No. 2376497). Social Science Research Network. <https://doi.org/10.2139/ssrn.2376497>

- Hummel, D., & Maedche, A. (2019). How effective is nudging? A quantitative review on the effect sizes and limits of empirical nudging studies. *Journal of Behavioral and Experimental Economics*, 80, 47-58. <https://doi.org/10.1016/j.socec.2019.03.005>
- Ito, K. (2015). Asymmetric Incentives in Subsidies: Evidence from a Large-Scale Electricity Rebate Program. *American Economic Journal: Economic Policy*, 7(3), 209-237. <https://doi.org/10.1257/pol.20130397>
- Iyengar, S. S., & Kamenica, E. (2010). Choice proliferation, simplicity seeking, and asset allocation. *Journal of Public Economics*, 94(7), 530-539. <https://doi.org/10.1016/j.jpubeco.2010.03.006>
- Iyengar, S. S., & Lepper, M. R. (2000). When choice is demotivating: Can one desire too much of a good thing? *Journal of Personality and Social Psychology*, 79(6), 995-1006. <https://doi.org/10.1037/0022-3514.79.6.995>
- Japan Ministry of Health, Labor, and Welfare. (2024). *Japan Longevity Statistics*. <https://www.stat.go.jp/english/data/handbook/index.html>
- Johnson, E. J., Shu, S. B., Dellaert, B. G. C., Fox, C., Goldstein, D. G., Häubl, G., Larrick, R. P., Payne, J. W., Peters, E., Schkade, D., Wansink, B., & Weber, E. U. (2012). Beyond nudges: Tools of a choice architecture. *Marketing Letters*, 23(2), 487-504. <https://doi.org/10.1007/s11002-012-9186-1>
- Kahneman, D. (2011). *Thinking, fast and slow*. Farrar, Straus and Giroux.
- Kahneman, D., & Frederick, S. (2002). Representativeness Revisited: Attribute Substitution in Intuitive Judgment. In D. Griffin, D. Kahneman, & T. Gilovich (Red.), *Heuristics and Biases: The Psychology of Intuitive Judgment* (pp. 49-81). Cambridge University Press. <https://doi.org/10.1017/CBO9780511808098.004>
- Kahneman, D., & Tversky, A. (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica*, 47(2), 263-291. <https://doi.org/10.2307/1914185>

- Karlan, D., McConnell, M., Mullainathan, S., & Zinman, J. (2016). Getting to the Top of Mind: How Reminders Increase Saving. *Management Science*, 62(12), 3393-3411.
- Kontis, V., Bennett, J. E., Mathers, C. D., Li, G., Foreman, K., & Ezzati, M. (2017). Future life expectancy in 35 industrialised countries: Projections with a Bayesian model ensemble. *Lancet (London, England)*, 389(10076), 1323-1335.
[https://doi.org/10.1016/S0140-6736\(16\)32381-9](https://doi.org/10.1016/S0140-6736(16)32381-9)
- Kruglanski, A. W., & Gigerenzer, G. (2011). Intuitive and deliberate judgments are based on common principles. *Psychological Review*, 118(1), 97-109.
<https://doi.org/10.1037/a0020762>
- Laibson, D. (1997). Golden Eggs and Hyperbolic Discounting. *The Quarterly Journal of Economics*, 112(2), 443-477.
- LeBaron, A. B., & Kelley, H. H. (2021). Financial Socialization: A Decade in Review. *Journal of Family and Economic Issues*, 42(1), 195-206.
<https://doi.org/10.1007/s10834-020-09736-2>
- Loewenstein, G., O'Donoghue, T., & Bhatia, S. (2015). Modeling the interplay between affect and deliberation. *Decision*, 2(2), 55-81. <https://doi.org/10.1037/dec0000029>
- Louria, D. B. (2005). Extraordinary Longevity: Individual and Societal Issues. *Journal of the American Geriatrics Society*, 53(9s), S317-S319. <https://doi.org/10.1111/j.1532-5415.2005.53499.x>
- Lusardi, A., & Mitchell, O. S. (2011). *Financial Literacy and Planning: Implications for Retirement Wellbeing* (Working Paper No. 17078). National Bureau of Economic Research. <https://doi.org/10.3386/w17078>
- Lusardi, A., Mitchell, O. S., Mitchell, O. S., & Lusardi, A. (Red.). (2011). Financial Literacy and Planning: Implications for Retirement Well-being. In *Financial Literacy:*

- Implications for Retirement Security and the Financial Marketplace* (p. 0). Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780199696819.003.0002>
- Madrian, B. C., & Shea, D. F. (2001). The Power of Suggestion: Inertia in 401(k) Participation and Savings Behavior*. *The Quarterly Journal of Economics*, 116(4), 1149-1187. <https://doi.org/10.1162/003355301753265543>
- Maier, M., Bartoš, F., Stanley, T. D., Shanks, D. R., Harris, A. J. L., & Wagenmakers, E.-J. (2022). No evidence for nudging after adjusting for publication bias. *Proceedings of the National Academy of Sciences*, 119(31), e2200300119. <https://doi.org/10.1073/pnas.2200300119>
- Melnikoff, D. E., & Bargh, J. A. (2018). The Mythical Number Two. *Trends in Cognitive Sciences*, 22(4), 280-293. <https://doi.org/10.1016/j.tics.2018.02.001>
- Mertens, S., Herberz, M., Hahnel, U. J. J., & Brosch, T. (2022). The effectiveness of nudging: A meta-analysis of choice architecture interventions across behavioral domains. *Proceedings of the National Academy of Sciences of the United States of America*, 119(1), e2107346118. <https://doi.org/10.1073/pnas.2107346118>
- Miles, D. (2023). Macroeconomic impacts of changes in life expectancy and fertility. *The Journal of the Economics of Ageing*, 24, 100425. <https://doi.org/10.1016/j.jeoa.2022.100425>
- Modigliani, F. (1986). Life Cycle, Individual Thrift, and the Wealth of Nations. *The American Economic Review*, 76(3), 297-313.
- Mugg, J. (2018). The sound-board account of reasoning: A one-system alternative to dual-process theory. *Philosophical Psychology*, 31(7), 1046-1073. <https://doi.org/10.1080/09515089.2018.1476680>
- Mullainathan, S., & Shafir, E. (2013). *Scarcity: Why having too little means so much* (p. 289). Times Books/Henry Holt and Co.

- Münscher, R. (2024). Choice architecture techniques: Developing a comprehensive taxonomy to test applicability in business relationships. *Management Decision*, 62(11), 3383-3403. <https://doi.org/10.1108/MD-06-2023-1091>
- Münscher, R., Vetter, M., & Scheuerle, T. (2016). A Review and Taxonomy of Choice Architecture Techniques. *Journal of Behavioral Decision Making*, 29(5), 511-524. <https://doi.org/10.1002/bdm.1897>
- O'Donoghue, T., & Rabin, M. (2015). Present Bias: Lessons Learned and to Be Learned. *American Economic Review*, 105(5), 273-279. <https://doi.org/10.1257/aer.p20151085>
- OECD. (2019). *Pensions at a Glance 2019: OECD and G20 Indicators*. Organisation for Economic Co-operation and Development. https://www.oecd-ilibrary.org/social-issues-migration-health/pensions-at-a-glance-2019_b6d3dcfc-en
- OECD. (2023). *Pensions at a Glance 2023*. <https://www.oecd-ilibrary.org/content/publication/678055dd-en>
- OECD. (2024). *How's Life? 2024: Well-being and Resilience in Times of Crisis*. OECD. <https://doi.org/10.1787/90ba854a-en>
- Oeppen, J., & Vaupel, J. W. (2002). Broken Limits to Life Expectancy. *Science*, 296(5570), 1029-1031. <https://doi.org/10.1126/science.1069675>
- Osman, M. (2020). *Backfiring, reactance, boomerang, spillovers, and rebound effects: Can we learn anything from examples where nudges do the opposite of what they intended?* PsyArXiv. <https://doi.org/10.31234/osf.io/ae756>
- Riley, J. C. (2005). Estimates of Regional and Global Life Expectancy, 1800–2001. *Population and Development Review*, 31(3), 537-543. <https://doi.org/10.1111/j.1728-4457.2005.00083.x>

- Ritchie, H., Rod s-Guirao, L., Mathieu, E., Gerber, M., Ortiz-Ospina, E., Hasell, J., & Roser, M. (2024). Population Growth. *Our World in Data*.
<https://ourworldindata.org/population-growth>
- Sabelhaus, J., & Volz, A. H. (2019). *Are Disappearing Employer Pensions Contributing to Rising Wealth Inequality?* <https://www.federalreserve.gov/econres/notes/feds-notes/are-disappearing-employer-pensions-contributing-to-rising-wealth-inequality-20190201.html>
- Samuelson, W., & Zeckhauser, R. (1988). Status quo bias in decision making. *Journal of Risk and Uncertainty*, 1(1), 7-59. <https://doi.org/10.1007/BF00055564>
- Scheibehenne, B., Greifeneder, R., & Todd, P. M. (2010). Can There Ever Be Too Many Options? A Meta-Analytic Review of Choice Overload. *Journal of Consumer Research*, 37(3), 409-425. <https://doi.org/10.1086/651235>
- Schneider, O. (2009). Reforming Pensions in Europe: Economic Fundamentals and Political Factors. *Czech Journal of Economics and Finance (Finance a Uver)*, 59(4), 292-308.
- Schwartz, B. (2004). *The paradox of choice: Why more is less* (pp. xi, 265). HarperCollins Publishers.
- Sheeran, P., & Webb, T. L. (2016). The Intention–Behavior Gap. *Social and Personality Psychology Compass*, 10(9), 503-518. <https://doi.org/10.1111/spc3.12265>
- Shefrin, H. M., & Thaler, R. H. (1988). The Behavioral Life-Cycle Hypothesis. *Economic Inquiry*, 26(4), 609-643. <https://doi.org/10.1111/j.1465-7295.1988.tb01520.x>
- Sloman, S. A. (1996). The empirical case for two systems of reasoning. *Psychological Bulletin*, 119(1), 3-22. <https://doi.org/10.1037/0033-2909.119.1.3>
- Smith, E. R., & DeCoster, J. (2000). Dual-Process Models in Social and Cognitive Psychology: Conceptual Integration and Links to Underlying Memory Systems.

Personality and Social Psychology Review, 4(2), 108-131.

https://doi.org/10.1207/S15327957PSPR0402_01

Stanovich, K. (2009). Distinguishing the reflective, algorithmic, and autonomous minds: Is it time for a tri-process theory? In J. Evans & K. Frankish (Red.), *In two minds: Dual processes and beyond* (p. 0). Oxford University Press.

<https://doi.org/10.1093/acprof:oso/9780199230167.003.0003>

Stanovich, K., & West, R. (2000). Individual differences in reasoning: Implications for the rationality debate? *Behavioral and Brain Sciences*, 23(5), 645-665.

<https://doi.org/10.1017/S0140525X00003435>

Sunstein, C. R. (2014). *Nudging: A Very Short Guide* (SSRN Scholarly Paper No. 2499658).

<https://doi.org/10.2139/ssrn.2499658>

Szaszi, B., Higney, A., Charlton, A., Gelman, A., Ziano, I., Aczel, B., Goldstein, D. G., Yeager, D. S., & Tipton, E. (2022). No reason to expect large and consistent effects of nudge interventions. *Proceedings of the National Academy of Sciences*, 119(31), e2200732119. <https://doi.org/10.1073/pnas.2200732119>

Szaszi, B., Palinkas, A., Palfi, B., Szollosi, A., & Aczel, B. (2018). A Systematic Scoping Review of the Choice Architecture Movement: Toward Understanding When and Why Nudges Work. *Journal of Behavioral Decision Making*, 31(3), 355-366.

<https://doi.org/10.1002/bdm.2035>

Thaler, R. (1985). Mental Accounting and Consumer Choice. *Marketing Science*, 4(3), 199-214.

Thaler, R. H., & Benartzi, S. (2004). Save More Tomorrow™: Using Behavioral Economics to Increase Employee Saving. *Journal of Political Economy*, 112(S1), S164-S187.

<https://doi.org/10.1086/380085>

Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decisions about health, wealth, and happiness* (pp. x, 293). Yale University Press.

Thompson, V. A., Prowse Turner, J. A., & Pennycook, G. (2011). Intuition, reason, and metacognition. *Cognitive Psychology*, 63(3), 107-140.
<https://doi.org/10.1016/j.cogpsych.2011.06.001>

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science*, 185(4157), 1124-1131. <https://doi.org/10.1126/science.185.4157.1124>

Van Bavel, J. (2013). The world population explosion: Causes, backgrounds and projections for the future. *Facts, Views & Vision in ObGyn*, 5(4), 281-291.

Van Dessel, P., Boddez, Y., & Hughes, S. (2022). Nudging societally relevant behavior by promoting cognitive inferences. *Scientific Reports*, 12(1), Article 1.
<https://doi.org/10.1038/s41598-022-12964-1>

Vandresse, M. (2021). *Demographic outlook 2020-2070* (Forecasts & Outlook No. POP2070_12389; Belgian Demographic Outlook). Federal Planning Bureau.
https://www.plan.be/publications/publication-2104-en-2020_2070_2020_2070_demographic_outlook_reference_alternative_scenarios

Vladeck, B. C. (2005). Economic and Policy Implications of Improving Longevity. *Journal of the American Geriatrics Society*, 53(9s), S304-S307. <https://doi.org/10.1111/j.1532-5415.2005.53495.x>

Vlaev, I., Chater, N., & Stewart, N. (2009). Dimensionality of Risk Perception: Factors Affecting Consumer Understanding and Evaluation of Financial Risk. *Journal of Behavioral Finance*, 10(3), 158-181. <https://doi.org/10.1080/15427560903167720>

Vosylis, R., & Klimstra, T. (2022). How Does Financial Life Shape Emerging Adulthood? Short-Term Longitudinal Associations Between Perceived Features of Emerging

Adulthood, Financial Behaviors, and Financial Well-Being. *Emerging Adulthood*, 10(1), 90-108. <https://doi.org/10.1177/2167696820908970>

Voudouri, A., Białek, M., & De Neys, W. (2024). Fast & slow decisions under risk: Intuition rather than deliberation drives advantageous choices. *Cognition*, 250, 105837. <https://doi.org/10.1016/j.cognition.2024.105837>

Wason, P., & Evans, J. (1974). Dual processes in reasoning? *Cognition*, 3(2), 141-154. [https://doi.org/10.1016/0010-0277\(74\)90017-1](https://doi.org/10.1016/0010-0277(74)90017-1)

Xie, Y., Hwang, S., & Pantelous, A. A. (2017). *Loss Aversion around the World: Empirical Evidence from Pension Funds* (SSRN Scholarly Paper No. 2757082). Social Science Research Network. <https://doi.org/10.2139/ssrn.2757082>

2

Keep the Change. A Low-Barrier Behavioral Intervention to Enroll Young Adults in Roundup Investing

Mathias Celis, Mona Bassleer, Kris Boudt, Wouter Duyck, and Nicolas Dirix.

Abstract

In the rapidly evolving financial landscape, young adults face unprecedented challenges in managing their finances, necessitating innovative solutions to foster prudent financial behaviors. This study examines the efficacy of behavioral nudges in enhancing financial decision-making among young adults. Preceding their 18th birthday, 1144 participants ($M_{\text{Age}} = 17.12$), recruited from the last year of secondary education, were invited by their bank to enroll in a roundup investing program, which rounds up every card transaction to the next round number and automatically invests the spare change. Using a 2x3 factorial design, we investigate the effectiveness of a low-barrier "set-and-forget" default nudge on the decision to enroll, either as a possibility to opt-in, or as a default with the possibility to opt-out. Additionally, we explore the effectiveness of conveying static peer norms (SPN), and norms that disclose changes in peer behavior over time, dynamic peer norms (DPN) on enrollment decisions. The default condition almost doubled enrollment (60.5% vs. 34.2%). Neither SPN nor DPN significantly affect enrollment decisions, challenging the assumed efficacy of peer influence on financial behavior in digital environments. Financial literacy and self-efficacy also boosted enrollment. Our study offers financial institutions, educators, and policymakers valuable insights on leveraging behavioral insights to support young adults in navigating their financial futures. By prioritizing behavioral influence techniques, stakeholders can empower young adults to make informed financial decisions, laying the groundwork for their long-term financial well-being.

Statement of Relevance

Young adults face immense challenges navigating today's complex financial landscape. As they shoulder increasing responsibility for their financial future, new technological advancements introduce a range of financial products at an unprecedented pace. Despite the proven benefits of many of these products, adoption rates remain low. One such high-impact, low-barrier innovative product is the roundup investing program. This program rounds up every card transaction to the nearest whole number and automatically invests the difference, enabling consumers to save while they spend, without any cognitive effort.

This study explores how financial institutions can significantly influence the enrollment decisions of young adults into these programs. We suggest employing a "set-and-forget" default nudge to enhance financial decision-making capabilities and guide young adults toward long-term financial well-being, all while respecting freedom of choice.

Our findings challenge the conventional wisdom on the persuasive power of static and dynamic peer norms in financial decisions, suggesting their limited impact on enrollment decisions. Additionally, we reaffirm the vital roles of financial literacy and self-efficacy in financial decision-making, suggesting that improving these attributes could lead to better financial outcomes.

We contribute to the literature as the first to our knowledge to examine the uptake decisions for roundup investing programs. We provide actionable insights for financial institutions, policymakers, and educators working to nurture responsible financial habits among young adults. Our findings advocate for a holistic approach that combines theoretical perspectives, practical applications, and policy directives to cultivate a financially literate, capable, and resilient younger generation, prepared to navigate an evolving economic environment.

Introduction

Today's financial landscape is becoming increasingly difficult to navigate. On the one hand, technological innovation, quickly expanding product offerings (that are hard to compare), and automation are contributing to this trend (Broby, 2021; Uribe-Linares et al., 2023). On the other hand, financial institutions and policymakers increasingly look to the individual to take responsibility for their financial situation (Lusardi & Messy, 2023). This trend starkly diverges from the increasing expectation among consumers for financial institutions and regulators to take a more proactive role in assisting them with their financial management (Sarkar, 2020).

Young adult populations worldwide appear to be underprepared for the financial challenges ahead. The OECD's Programme for International Student Assessment (PISA) measures how well 15-year-olds from 20 participating countries, representing around 13.5 million young adults, understand and can apply financial knowledge and skills essential for future financial planning and decision-making. Even in sophisticated economies with mature financial markets, financial literacy levels remain very low (Mitchell & Lusardi, 2011). The most recent PISA measurement further highlights this concerning trend (OECD, 2018). In several G20 countries, such as Indonesia, Brazil, and Italy, about 20-60 percent of students do not achieve the most basic proficiency in financial literacy. In other developed nations like Australia, Spain, and the United States, this percentage exceeds 15%, still representing a substantial segment of the youth population. Consequently, youth have been identified as one of the priority focuses of government initiatives aiming to enhance financial literacy in their strategic efforts (OECD, 2017).

The mastery of financial literacy is crucial for empowering the youth to effectively manage their finances, thereby laying a foundation for financial security, asset accumulation, and the fulfillment of personal ambitions and goals. However, contrary to expectations,

multiple studies indicate that interventions (such as educational courses) aimed at improving adolescent personal finance have little to no impact on one's financial proficiency or behaviors in adulthood (Cole et al., 2009; Johan et al., 2021; Menard, 2017). In addition, recent review studies reveal that the average effect of financial education on financial behaviors in interventions is small (Hedges g

¹ between 0.018 and 0.1) (Fernandes et al., 2014; Kaiser et al., 2020). Despite receiving financial literacy training during their formative years, individuals do not demonstrate better financial knowledge or behaviors than their untrained peers, as confirmed by follow-up research one and four years later (Mandell & Klein, 2009; Shanks et al., 2013; Totenhagen et al., 2015).

In recent years, "Financial capability" has emerged as a more favored term among professionals, policymakers, and scholars (Luukkanen & Uusitalo, 2019). According to the widely accepted definition, achieving financial capability necessitates not only access to suitable financial services but also the development of essential knowledge, skills, attitudes, and behaviors for making sound financial choices (Birkenmaier et al., 2022). It is generally believed that increasing financial literacy and access to financial services synergistically promote responsible financial behaviors, like investing habits (Shanks et al., 2013).

While access and education can certainly improve knowledge, skills, intentions, and attitudes, they are typically not the strongest predictors of future behavior (Birkenmaier et al., 2019). More often, past behavior and self-efficacy tend to be more reliable forecasters (Clark et al., 2012; Conner & Norman, 2022). Self-efficacy refers to the belief in one's ability to perform tasks, which promotes greater effort and persistence successfully (Maddux, 1995). This belief is mostly shaped by past performance and social information, such as being

¹ Hedges' g is a standardized statistical measure comparable to Cohen's d , that estimates the effect size between two means. It corrects for small sample sizes to reduce Type I errors and allows for standardized comparisons across different studies.

informed of others' successes or failures (Bandura, 1997). In an economic context, financial self-efficacy (FSE) refers to the belief in one's ability to manage and control personal financial matters. It influences financial behavior and decision-making processes, improving long-term economic health (Chowdhry & Dholakia, 2020; Lown, 2011).

In addition to overlooking the influence of past behavior and FSE, current financial capability models view its behavioral component as a passive outcome variable, rather than a direct target for intervention (Birkenmaier et al., 2022). This approach neglects the potential of actively influencing financial behavior through behavioral change interventions. Findings from behavioral economics literature suggest that tailored behavioral interventions can effectively promote desired financial behaviors (Dolan et al., 2012; Thaler & Sunstein, 2008).

There is growing evidence that suggests individual characteristics, such as financial literacy and self-efficacy, may shape how individuals respond to behavioral interventions. Financial literacy enhances the ability to understand and process options, potentially strengthening the influence of interventions aimed at simplifying decision-making (Fernandes et al., 2014; Kaiser & Menkhoff, 2017). For example, individuals who score higher on financial literacy may be more likely to recognize the benefits of default enrollment, while those with lower financial literacy might rely more on automatic, intuitive processing, amplifying the intervention's impact. Similarly, self-efficacy has been linked to greater persistence in positive financial behaviors, suggesting that interventions targeting these traits could further enhance financial outcomes (Bandura, 1997; Lown, 2011). Therefore, employing a more behaviorally driven model of financial capability could significantly impact both theory and policy interventions aimed at increasing financial capability.

Making the right financial decisions at pivotal moments can make the difference between financial stability and a future plagued by economic hardship (LeBaron & Kelley, 2021; Pak et al., 2023; Vosylis & Klimstra, 2022). Given our natural inclination to stick with

the status quo, adopting automatic financial behaviors, those requiring little to no future cognitive effort can be a game-changer for long-term financial well-being (Mamidala et al., 2023). Therefore, this study investigates the effectiveness of various behavioral change interventions in promoting automatic financial behaviors among young adults. In particular, we focus on the impact of set-and-forget default nudges, an intervention that directly targets financial behaviors, to help young adults overcome the behavioral barrier to start and keep investing in an innovative, low-barrier way. In addition, this study explores the role of two forms of normative influence in steering financial decision-making: static peer norms (SPN), and dynamic peer norms (DPN). The former (SPN) refers to information that explains the current state of behavior within a relevant peer group, such as the percentage of people currently vaccinated against influenza (Graupensperger et al., 2021). The latter (DPN) describes information that discloses changes in peer behavior over time, such as the changes in the percentage of vaccine take-up over the last few months (Geber et al., 2022). Furthermore, the study accounts for the influence of gender, financial self-efficacy, and financial literacy.

The Biases That Withhold Us From Sound Financial Behavior

Traditional economic theories assume that individuals approach financial decisions as rational agents, who are capable of acting logically in accordance with their best interest and long-term goals (Kahneman, 2011; Stetzka, 2024). However, emerging research in behavioral economics contests this logic by highlighting how, even in the presence of the right intentions, psychological and contextual factors, known as *biases*, heavily influence our decision-making and behavior, often leading us to make sub-optimal choices (Dolan et al., 2012; Kahneman, 2003; Milkman et al., 2011). In the context of hindering sound financial behavior, numerous biases have been identified.

Status Quo Bias

People have the natural tendency to favor the current state of affairs and resist change, even when change could lead to better outcomes (Samuelson & Zeckhauser, 1988). This bias is found across all domains of life, from our daily meal choices to the route we commute to work and the politicians we vote for (Godefroid et al., 2023). In financial decision-making, it often results in inertia, such as the reluctance to switch to more beneficial financial products or services because of our loss/uncertainty-averse nature associated with change, and influences from our social environment (Alós-Ferrer et al., 2016; Menezes & Hanson, 1970; Muchnik et al., 2013).

Present Bias

A robust body of research confirms that people tend to prioritize immediate rewards over future gains, even when those future gains are significantly larger (Sheeran & Webb, 2016; Xiao & Porto, 2019). In a financial decision environment, where the act of saving for a distant future self, requires recurring discipline and cognitive control and where the allure of immediate gratification overshadows the benefits of future savings, this bias becomes even more pronounced (O'Donoghue & Rabin, 2015). The temptation of immediate gratification, often amplified by banking apps that make spending feel more satisfying than saving or investing, underscores the challenge of prioritizing long-term financial well-being (Bayuk & Altobello, 2019).

Loss and Risk Aversion

The fear of loss and aversion to risk heavily influence financial decisions. People commonly opt for the security of a predictable outcome over engaging in risks, even when the potential gains significantly outweigh the potential losses (Kahneman & Tversky, 1979). These biases often lead to sub-optimal economic decisions and fail to capitalize on potential opportunities. Both the status quo bias and loss aversion foster financial inertia, as individuals

default to inaction fueled by uncertainty and risk avoidance and the perceived effort to initiate change (Gal, 2006).

Conformity Bias

Human decision-making does not happen in a vacuum. We heavily rely on social and contextual cues to form opinions and guide our choices. This inclination to align one's thoughts and actions with those of a group, rather than relying on personal judgment, is known as conformity bias (Moscovici et al., 1969). This phenomenon occurs as individuals observe and adopt the prevailing attitudes or behaviors within a group they are part of, wish to be part of, or find themselves in, as a benchmark for determining what is deemed correct or suited (Asch, 1956). Many economic behaviors like saving and investing, happen in complete privacy and increasingly in a digital environment (Kaustia & Knüpfer, 2011; Raue et al., 2020). As youth are more than ever relying on the digitized and aggregated opinions and social cues of their peers (Jain & Stuart, 2022), it is crucial to consider the profound impact of conformity bias on their financial decision-making. This bias can both positively and negatively affect young adults' financial behaviors, leading to either prudent or risky investment strategies depending on the prevailing norms within their peer group. In a notable instance, the r/WallStreetBets Reddit saga with GameStop showcased how conformity bias in a digital context can drive collective action in financial markets (Mancini et al., 2022). Amateur investors, primarily youth, were influenced by the aggregated opinions on this online forum to collectively invest in GameStop stocks, challenging institutional investors and causing significant market fluctuations.

Together, these biases not only illuminate the complexities and vulnerabilities of financial decision-making but also underscore the potential for designing financial tools and behavioral interventions that leverage these psychological underpinnings, promoting a shift

from intention to action by making saving as intuitive and rewarding as spending or by reducing cognitive control needed to perform ‘good’ economic behavior.

This complexity in decision-making, where emotions and cognitive biases override rational evaluation, presents a challenge for many banking customers seeking to navigate their finances (Miah, 2023; Uribe-Linares et al., 2023).

Existing Initiatives

Emerging fintech and neo-banks are rapidly innovating the consumer economic landscape with new product offerings, innovative approaches to accessing and managing financial services and tools to aid individuals make better financial decisions. These innovations caused a ‘fintech revolution’ (Chen et al., 2019; Miah, 2023), which paved the way for established financial institutions to explore novel initiatives (Faour & Al-Sowaidi, 2023).

Examples include mobile banking apps that leverage mental accounting principles aimed at helping clients save money for specific goals (Gargano, 2021; Horton et al., 2024), real-time ‘overspending’ notifications (Lee, 2019), apps to promote retirement planning by having clients upload photos to visualize aging, and influencing financially beneficial decisions (Robalino et al., 2023). Other banking apps are actively reducing complexity and barriers to entry for investing by adopting a gamified interface, which makes investing and banking feel more like a game to appeal to younger, less experienced investors (Baker & Odinet, 2023; Krishnan, 2014).

One particular intervention that has been largely adopted and implemented through the fintech revolution are “roundup investing/saving” initiatives (Horton et al., 2024; Sardar & Anjaria, 2023). This low-barrier initiative was first introduced around 2005 by Bank of America to simplify saving and investing by automatically rounding up card transactions to the next round number and allocating the difference to a dedicated savings or investment

account (Bank of America, 2005). According to Thompson (2019) reports that when Bank of America introduced this program in 2005, it attracted 2 million customers within the first year. By 2019, enrollment had surged to over 12 million active users, collectively saving \$2 billion. Notably, three out of five new Bank of America customers opt to join the program, and an impressive 99% of enrollees continue to participate.

We illustrate the scheme's potential using the following example: For instance, if an 18-year-old starts with roundup investing, assuming they buy one coffee five times a week, dedicating €0.75 from each coffee purchase into this scheme, could yield spectacular returns. By the time they reach 65, the foresight of this modest investment strategy, even after adjusting for a 0.5% fee/tax and an annual conservative return rate of 5%, could yield around €31,079.10.

The core idea behind round-up investing is that individuals only need to make one decision to enroll and don't need to change their behavior in any way. These people can continue spending as they did before enrollment, but now, thanks to their enrollment, they invest passively in the background while they spend. This ingenious intervention leverages several innate behavioral biases: present bias (favoring immediate rewards over larger future ones), inertia (sticking to the status quo), complexity aversion (overwhelming financial jargon and choice overload), and loss/regret aversion (disliking losses and regrets). By simplifying and automating the process of investing for one's future self through microtransactions that 'don't hurt the wallet' in the present, it provides a low-barrier way to invest while spending, without needing to exert cognitive control. Such microtransactions take advantage of 'narrow choice bracketing', which refers to the tendency of individuals to evaluate decisions in isolation rather than in their bigger context, leading to the perceived insignificance of small, repeated transactions (Read et al., 1999). This systematic underestimation or disregard for multiple small amounts of money is also known as the 'peanuts effect'. Likewise, in the

context of roundup investing, the ‘spare change’ from a purchase can be perceived as ‘peanuts’, seemingly insignificant on its own, while they add up to a significant total expenditure with time. This perception reduces the psychological pain associated with saving/investing, as each rounded-up amount appears trivial and does not evoke the sense of loss that a larger, one-time transaction might.

Yet, despite its promising results in the field, the means to improve participation in this type of intervention have, to our knowledge, not been studied in an academic context to date. We found only one study that investigates these types of interventions in the context of increasing donations by rounding up at checkout. Kelting et al. (2019) found that individuals respond more favorably to a roundup donation request, compared to a flat donation request, even when amounts are identical. The authors ascribe the effect to a reduced experienced loss aversion, or ‘pain of donating’. Although fintech innovations hold great promise in transforming financial behaviors effortlessly, the challenge remains in optimizing participation rates (Singh et al., 2020).

Nudging

To address this gap, behavioral scientists employ ‘choice architecture’ to subtly influence decisions without limiting choice alternatives or significantly altering economic incentives, a concept introduced as “nudging” by Thaler & Sunstein (2008). To count as a nudge, the intervention must be easy and cheap to avoid (Sunstein, 2019). Examples of nudges are the placement of healthy foods in a cafeteria at eye level or providing households with feedback on own and peers’ electricity usage to encourage energy conservation (Chapman et al., 2019; Costa & Kahn, 2010). The theoretical foundation for nudging is rooted in dual-processing theory, which describes how humans think and decide (Evans, 2008). According to this theoretical framework, cognitive processes can be divided into two distinct metaphorical cognitive systems: System 1 & System 2 (Kahneman, 2011). The quick,

automatic, and intuitive System 1 requires little effort and is driven by prior experiences and instinct. In contrast, System 2 can be seen as our more reflective, logical, and deliberate thought processes that demand substantial cognitive resources. Due to the energy-consuming nature of System 2, individuals often default to employing System 1, leading to impulsive behavior, which in most cases can be identified as the source of many of our biases.

According to Rooij & Favela (2016) Behaviors can stem from either system or both combined. However, this traditional view of System 1 as primarily a source of bias has been challenged by recent research.

Emerging theoretical developments question the strict dichotomy of dual-processing theory, proposing that intuitive and deliberative processes are not as distinctly exclusive as traditionally conceptualized (De Neys, 2021). De Neys (2023) suggests substantial overlap between the two systems, where intuitive processes occasionally drive decisions previously thought to require deliberate reasoning. For instance, intuitive conflict detection mechanisms can identify inconsistencies or errors in heuristics, thereby signaling System 2 to intervene and engage in deliberation. This dynamic interplay reveals that people are able to generate logically sound or financially advantageous choices through purely intuitive processing, even under time pressure and cognitive load (De Neys, 2022; Voudouri et al., 2024).

Such contemporary frameworks propose that System 1 can generate multiple competing intuitions simultaneously, both heuristic-based (e.g., loss aversion) and logic-based (e.g., expected value calculation). The relative strength of these intuitions, shaped by context and learning, determines the initial response. Even when making seemingly biased choices, people often show decreased decision confidence compared to control situations, suggesting implicit sensitivity to logical principles within intuitive processing (De Neys, 2023).

These advances suggest that behavioral interventions may succeed not by exploiting System 1 biases that require System 2 correction, but by influencing the relative strength of

competing intuitions and facilitating productive inferential processes (Van Dessel et al., 2022). In financial decision-making, effective interventions may work by strengthening goal-aligned intuitions through contextual cues that highlight both immediate feasibility and long-term benefits (Zhao et al., 2022). By understanding and working with this interplay between different types of intuitive processes, behavioral interventions can more effectively shape decision-making while respecting the sophistication of human cognition.

These recent theoretical advancements have sparked debate among academics regarding the average statistical effectiveness of nudging interventions after accounting for publication bias (Bakdash & Marusich, 2022; Maier et al., 2022; Mertens et al., 2022; Szaszi et al., 2022). Initially focused on a binary 'effect vs no effect' discussion, the consensus has shifted to a more nuanced understanding. While nudges don't typically lead to large effects, their aim is often behavioral change, where real-world impact may not be reflected in large-scale statistical effects. The value of these interventions lies in their cost-effectiveness compared to traditional policy measures like subsidies, bans, and information campaigns (Benartzi et al., 2017). Research shows that taking into account implementation costs, nudges surpass traditional policy instruments in effectiveness across most policy domains (Benartzi et al., 2017). Similarly, in light of improving youth financial capability, we suggest that directly influencing the behavioral component of financial capability through behaviorally informed interventions, like nudging, can be a cost-effective alternative to traditional interventions aimed at improving financial capability, such as financial education programs, increasing availability or awareness (Fernandes et al., 2014). This approach leverages recent insights about the sophisticated interplay between different types of intuitive processes, where interventions can strengthen goal-aligned intuitions rather than merely exploiting biases that require deliberative correction (De Neys, 2023). This approach can potentially address the

limitations of conventional models and contribute to the advancement of financial capability among youth.

While existing research primarily explores nudging in offline contexts, digital nudges have become increasingly relevant due to their prevalence in our daily lives. In digital spaces, users often exhibit autopilot behavior, quickly navigating apps and menus or accepting policies with little scrutiny (Rawlings, 2020). Early findings suggest that decision-making in a digital environment prompts more automatic and intuitive reactions, driven by the abundance of visual and informational stimuli, compared to offline environments (Monteith & Glenn, 2016; Schneider et al., 2017). This heightened reliance on intuitive processing underscores the importance of understanding how different types of intuitions may compete and interact in digital decision-making contexts. However, studies comparing the online and offline contexts find digital nudges to be at least as effective as offline ones, indicating their consistent influence across different environments. Given the trend that financial behaviors such as banking, investing, and payments, increasingly take place in apps and on digital platforms, the significance of deepening the knowledge of digital nudging in behavioral science research is evident (Hummel & Maedche, 2019; Mirsch et al., 2017; Weinmann et al., 2016).

Default Nudge

Changing the default option is a highly effective strategy to alter behavior and counteract status quo bias. Such nudges, which determine the outcome when no action is taken, significantly outperform other behavioral interventions, showing an average effect size of 0.62 (Hummel & Maedche, 2019). Defaults were traditionally thought to exploit System 1's automatic acceptance of the status quo, requiring System 2 effort to override this bias (Dinner et al., 2011). Recent theories suggest defaults work by frictionless aligning intuitive and deliberative processes, reinforcing beneficial intuitions (De Neys, 2023). This nuanced mechanism helps to explain their consistent effectiveness across contexts.

A notable example with high societal impact is the shift to an opt-out system in organ donation policies, leading to higher donation rates in several countries (Johnson & Goldstein, 2003). Similarly, in a financial context, defaults have proven very effective in positively influencing the saving behavior and retirement contributions of individuals (Beshears et al., 2009; Choukhmane, 2024; Goda & Flaherty Manchester, 2010). A famous example is the Save More Tomorrow™ (SMarT) program, which effectively boosts retirement savings by enabling employees to automatically increase their contributions with future salary raises (Thaler & Benartzi, 2004). The "set-and-forget" mechanism of SMarT leverages two biases to enhance financial decision-making. On the one hand, it capitalizes on inertia, allowing ongoing savings growth without further decisions or actions. On the other hand, it leverages present bias, given that no active, direct choice needs to be made between short and long term, as the behavior is enacted automatically. This approach minimizes cognitive strain and decision fatigue, ensuring sustained positive financial behavior and higher savings rates without immediate financial downsides.

Peer Influence

When considering influencing the behavior of adolescents, literature shows that this younger demographic is particularly sensitive to peer influence (van Hoorn et al., 2016). During this pivotal phase of life, emerging adults are in the process of forming their identities and exhibit a heightened desire to ‘fit in’ with their peer group (Laursen & Veenstra, 2021).

Peer influence operates through a dynamic interaction of cognitive mechanisms. Social cues often activate System 1, triggering intuitive, automatic responses like conformity to group norms (Cialdini et al., 1990; Kahneman, 2011). At the same time, System 2 may engage when individuals reflect on how these norms align with their identity and goals (Festinger, 1954). This interplay allows peer norms to guide behavior both instinctively and

deliberately, making them particularly effective during adolescence (De Neys, 2023; Rhodes et al., 2020).

Static Peer Norms (SPN)

People usually conform to dominant perceived norms in their environment (Cialdini et al., 1990). Social comparison theory further indicates that norms anchored in a relevant peer group to which an individual considers themselves an in-group member, increases comparability between the self and target group, effectively increasing the persuasive power of the norm (Festinger, 1954). Increasing the salience of peer actions to guide behavior has proven effective in various contexts (Rhodes et al., 2020). For example, Costa & Kahn (2010) and Nolan et al. (2008) show that households who are informed about their energy consumption, relative to their neighbors, substantially conform their energy use towards community norms. Such descriptive norm nudges provide static peer norms that allude to 'the dominant behavior' by sharing information about what a typical peer might do in a similar situation (Cialdini & Trost, 1998; Niemiec et al., 2020). These nudges work by leveraging the cognitive mechanisms that lie at the basis of conformity bias, our tendency to adjust behavior based on social cues, to fit in with our peer group (Cialdini et al., 1990). Research on the influence of social norms to steer economic decision-making is promising (e.g., Kuchler & Stroebe (2021); Banerjee & Das, (2023)), however, its effectiveness is not universal across contexts, as shown by Beshears et al. (2015) and Dur et al. (2021). Beshears et al. (2015) conducted a field experiment examining the impact of peer information on retirement savings. The intervention, which provided employees with information about their colleagues' savings behavior, unintentionally reduced savings among low-income participants. This outcome was attributed to upward social comparison, where individuals felt discouraged when comparing their financial behavior to peers with higher incomes, perceiving the norm as unattainable. Similarly, Dur et al. (2021) explored the effectiveness of a social norm nudge encouraging

low-saving households to save more, using a large-scale field experiment at a retail bank. While the intervention increased engagement, evidenced by more clicks on a savings setup page, it had no significant effect on actual savings behavior. The researchers suggested this disconnect could stem from a gap between intentions and actions, potential spillover effects, or mismatched reference groups.

These findings emphasize that while social norms hold potential to influence economic decisions, their success depends heavily on contextual factors, such as reference group relevance and the alignment between behavioral intentions and practical outcomes.

Dynamic Peer Norms (DPN)

In recent years, a noteworthy line of research within the study of normative social influence has emerged: dynamic or trending norm interventions. In contrast to descriptive (static) norms, dynamic norms provide information about recent collective *changes* or *trends* in behavior of (peer) groups over time (Cialdini & Jacobson, 2021). Empirical evidence from multiple studies shows that DPNs are often more effective in influencing behavioral change when compared to SPNs, which highlight a static level of prevalence (Cheng et al., 2022; Sparkman & Walton, 2017, 2019). According to Cialdini & Jacobson (2021), this highlights a normative influence bias to align behavior towards behavioral trends, which proves to be an effective adaptable mechanism in the rapidly changing natural world.

To date, the empirical literature on peer influence within a young adult demographic, concerning economic decision-making, is very scarce (Braams et al., 2019; Cialdini & Jacobson, 2021). We believe exposing young adults to peers who also perform positive economic behaviors (like investing), might positively influence financial decisions on a large scale. As youth matures, these (in)experiences with sound financial habits can become highly influential toward future financial behaviors in adulthood.

Current Study

The present study aims to explore the effectiveness of several nudges and their combinations on the decision to enroll in a roundup investing program among young adults. Our goal is to mitigate behavioral barriers, thereby enabling young adults to effortlessly initiate and sustain investment activities. To achieve this, we will deploy an online vignette study that introduces a low-barrier "set-and-forget" default nudge on a significant temporal landmark², their 18th birthday. Additionally, the study assesses the impact of peer information, both SPN and DPN, on enrollment behavior, while controlling for financial literacy, financial self-efficacy, and gender. This study is the first to our knowledge to test the effectiveness of behavioral interventions in increasing young adults' enrollment in roundup investing programs. As well as the first to challenge traditional financial capability models that view financial behavior primarily as an outcome variable influenced by factors like increasing access to suitable financial services, financial literacy, or attitudes. The following research questions guide the present study:

RQ1: Does a set-and-forget opt-out default nudge encourage young adults to enroll in an investing with pocket change program?

RQ2: What is the effect of peer norms (static and dynamic norms) on young adults' enrollment decisions?

RQ3: How does the interaction between peer norms (both static and dynamic) and the set-and-forget default nudge affect enrollment decisions?

RQ4: How do financial literacy, financial self-efficacy, and gender influence enrollment decisions?

² Temporal landmarks like the start of a new week or personal events that boost goal-oriented actions, make use of the "fresh start effect", allowing people to move past failures and boost their confidence. Savings and pension contributions often increase after birthdays or raises, showing these moments inspire and make goals appear more achievable (Dai et al., 2014).

Method

Participants

The study focused on young adults, residing in the Flemish-speaking region of Belgium. Recruitment was conducted via email and online learning platforms of secondary schools. To incentivize voluntary participation, students were offered the opportunity to win one of five duo cinema tickets, awarded randomly to participating students. A total of 1,144 participants (44.9% male, $M_{\text{Age}} = 17.12$ ($SD_{\text{Age}} = 0.96$) were recruited from the last two years of secondary education across various schools. Participants were enrolled in either general (39.6%), technical (39.6%), vocational (15.7%), or artistic secondary education (5.7%).

This study received formal approval from the university ethics board, with reference code 2021/138, FWO project nr.: S006721N. Prior to participation, all students were asked to provide active consent, affirming their voluntary participation in the online study conducted through the survey platform Qualtrics. No prior experience in financial decision-making or investing was necessary for participation. This study was conducted in strict adherence to the general ethical guidelines for scientific research. Participation was strictly voluntary, and all data were anonymized to maintain privacy and confidentiality. Participants were randomly assigned to one of six experimental conditions.

Design and Procedure

The current study employed an experimental design to explore the impact of default nudges, SPN, and DPN on the decision of young adults (not) to enroll in a roundup investing program. Participants were administered the study in Dutch, their school language, through an online questionnaire hosted on Qualtrics. The study featured a 2x3 factorial design with factors ‘Default’ (opt-in vs. opt-out) and ‘Peer Information’ (no info, SPN, DPN). Opt-in without peer information is established as the baseline condition. Participants were randomly assigned to one of the six experimental conditions, ensuring balanced group sizes. Each

participant was first asked for basic demographic and descriptive information. Afterward, they were presented with a vignette, prompting them to imagine nearing their 18th birthday and receiving an email from their bank inviting them to enroll in a roundup investing program, which would start at the temporal landmark of becoming an adult. This email described a roundup investing program where transactions are rounded up to the nearest euro, with the difference automatically invested once it accumulates to 10 euros. Depending on their assigned condition, participants then encountered one of the six variations of the enrollment invitation, incorporating either an opt-in or opt-out choice and, for some, additional information reflecting SPN or DPN. The full details of the conditions, including the operationalization of the dependent variable as presented to participants in Dutch, along with their English translations, are provided in *Supplementary Information (SI)* under the section titled 'Conditions'. Following this experimental manipulation, participants' Financial Self-Efficacy (FSE) and Financial Literacy were assessed using validated scales.

Financial Self-Efficacy

Financial Self-Efficacy was measured using the Financial Self-Efficacy Scale (FSSES) developed by Lown (2011). The survey included six items to assess individuals' confidence in managing their finances (e.g., "I am not confident in my ability to manage my finances", Cronbach's $\alpha = .73$) ($M = 37.0$, $SD = 18.6$). The individuals rated their agreement with the items on a Likert scale from 0 (= strongly disagree) to 100 (= strongly agree). The individual scores are the result of their averaged item scores.

Financial Literacy

Financial Literacy was assessed through the widely adopted 'Lusardi's Big Three' questions (Lusardi & Mitchell, 2011). The survey included three items, querying knowledge of interest rates, inflation, and diversification (e.g., "Suppose you had \$100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you

would have in the account if you left the money to grow?”, Cronbach’s $\alpha = .45$) ($M = 0.6$, $SD = 0.3$). Despite its rather low Cronbach’s alpha, the employment of Lusardi’s Big Three questions as a metric for financial literacy is warranted due to its demonstrated capacity to succinctly encapsulate the core dimensions of financial literacy across diverse prior studies and samples, with similar reported Cronbach’s alpha’s. This is evidenced by its substantial correlations with alternative financial literacy scales and their established predictive validity concerning real-world financial behaviors and attitudes (Rieger, 2020). Individuals answered each question by choosing from four answer options³. A correct answer was coded as 1, and an incorrect answer as 0. The individual scores are the result of their averaged item scores.

Analyses

To provide an overview of the data, we calculated descriptive statistics and Pearson correlations for the continuous variables. The full correlation matrix of all variables considered in the study can be found in (*SI*, Table S1). Default condition (opt-in vs. opt-out), Peer information conditions (No info, SPN, and DPN), Gender, FSE, and FL were included as the predictors, with the latter three acting as control variables, and enrollment decision as the dichotomous dependent variable in a binary logistic regression. Basic data cleaning was conducted, excluding incomplete data-entries, anomalies and participants younger than 16. Before studying the parameter estimates of the logistic regression, we checked our model fit through the Hosmer and Lemeshow Test. A p-value greater than .05 indicates a good fit, as it suggests that the differences between observed and predicted values are not significant, confirming the model’s adequacy (Hosmer & Lemeshow, 2013).

³ Only the last question has three answer options.

Results

We investigated the effect of default condition and peer information (No info, SPN and DPN), as well as their interaction effect on enrollment decisions in a roundup investing program. Based on the Hosmer and Lemeshow Test, the model fits the data well ($\chi^2(8, N = 1,144) = 7.61, p = .473$). The following results are consistently controlled for the other appearing predictors in the model. A binary logistic regression shows that the default condition significantly influences the enrollment decision. Students in the opt-out group are more likely to decide to save than those in the opt-in group, with enrollment rates of 60.5% versus 34.2%, respectively. This effect size is considered medium, with Cohen's $d = 0.55$.

The main effect of peer information on the enrollment decision, as well as the interaction effect with the default condition is non-significant. We find a small, negative correlation ($r = -.20, p < .001$) between the continuous covariates, FSE and FL. These furthermore have a significant effect on enrollment decision: The higher a student's FSE or FL level, the greater the odds of deciding to enroll versus deciding not to enroll. However, the effect size for FSE is very small (Cohen's $d = 0.005$), whereas the effect size for FL is small to medium (Cohen's $d = 0.34$).

The corresponding test statistics and parameter estimates can be found in Table 1, with a visual representation of the core results in Figure 1.

Table 1

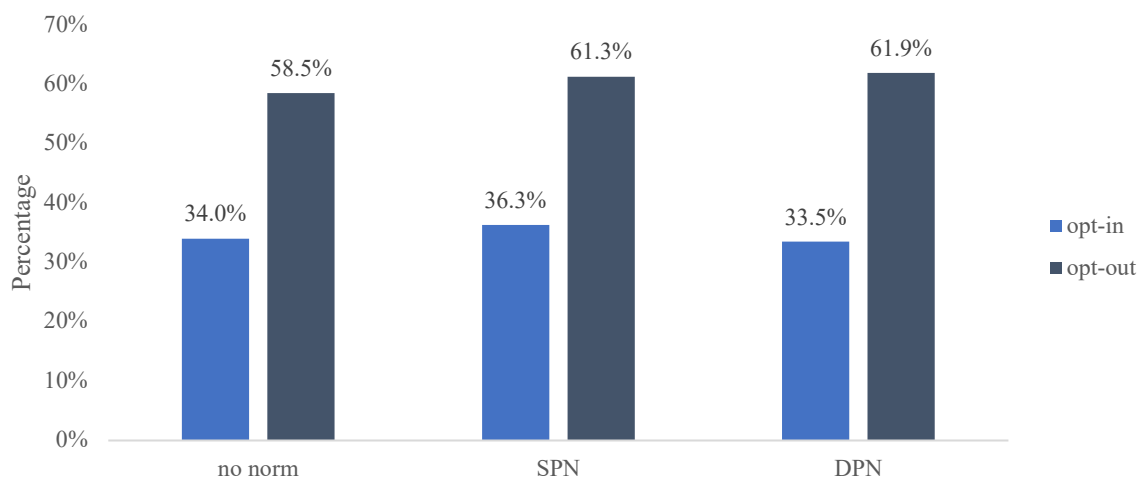
Test Statistics and Parameter Estimates Logistic Model for Logit Deciding to Save Versus Deciding Not to Save

	<i>B</i>	<i>SE</i>	Wald	df	Exp(<i>B</i>)
Default condition					
Opt-out	1.00	0.21	22.80***	1	2.73
Norm condition			1.33	2	
SPN	0.20	0.21	0.90	1	1.22
DPN	0.04	0.21	0.03	1	1.04
Condition*Norm condition			0.57	2	
Opt-out*SPN	-0.04	0.30	0.02	1	0.96
Opt-out*DPN	0.18	0.30	0.33	1	1.19
Gender					
Male	0.24	0.13	3.68	1	1.28
FSE	0.01	0.003	4.66*	1	1.01
FL	0.62	0.20	10.15**	1	1.86

Note. SPN = Static Peer Norms; DPN = Dynamic Peer Norms; FSE= Financial Self-Efficacy; FL= Financial Literacy. * $p < .05$, ** $p < .01$, *** $p < .001$. The reference categories for Default condition, Norm condition, and Gender are Opt-in, No norm, and Woman, respectively. Nagelkerke pseudo $R^2 = .107$.

Figure 1

The Enrollment Decision for Every Condition



Note. SPN = Static Peer Norms; DPN = Dynamic Peer Norms

Discussion

Young adults face the challenge of navigating an increasingly complex financial landscape, where seemingly small decisions can have substantial and lasting economic impact in later life. This study aimed to explore cost-effective and impactful behavioral interventions to optimize the financial decisions of young adults at a pivotal moment in their lifecycle.

Our study examined the influence of default nudges and peer information (no norms, SPN, and DPN) on the enrollment decision of young adults in an online roundup investing program. To our knowledge, no prior academic studies have focused on such promising and innovative programs, nor on strategies to enhance their adoption among young adults.

In response to the first research question (RQ1), our findings indicate that an 'opt-out' default condition significantly increases the likelihood of enrollment in the roundup investing program. This effect almost doubles enrollment rates, with 2.73 times higher odds of saving in the 'opt-out' group (60.5%) compared to the 'opt-in' group (34.2%), which is a 76.9% increase. This finding aligns with prior literature, suggesting that default settings can significantly shape decision-making (Hummel & Maedche, 2019; Johnson & Goldstein, 2003; Samuelson & Zeckhauser, 1988). The effectiveness of our 'opt-out' effect can be attributed to several factors. Firstly, an opt-out choice environment drastically simplifies the decision-making process by providing a frictionless path that requires no active decision-making, which aligns with the automaticity of System 1 thinking Kahneman (2011). According to 'nudge theory', people are cognitively lazy and inclined to go with the flow of pre-set options, particularly when the decision is complex or they are ambivalent about the outcome (Kahneman, 2011; Thaler & Sunstein, 2008). In such cases, the default option serves as an implicit recommendation, reducing cognitive effort and uncertainty (Johnson & Goldstein, 2003). This tendency to stick with defaults exploits present bias, status quo bias, and inertia. These biases reflect our preference for the current state of affairs and the fact that no active

choice needs to be made between short and long-term benefits, as the behavior is enacted automatically (Kahneman & Tversky, 1979). Furthermore, we believe the opt-out default to be particularly sticky in the case of roundup investing. Because the recurring roundups are small and often dismissed as insignificant due to 'narrow choice bracketing' and the 'peanuts effect', the roundup program serves as an easy entry point for individuals to begin investing (Read et al., 1999). This simplicity and low perceived risk make the decision less overwhelming, while encouraging behavioral consistency, as individuals are more likely to continue participating once automatically enrolled (Thaler & Benartzi, 2004). Once enrolled, individuals might perceive opting out as a loss, indirectly leveraging loss aversion to sustain participation.

Additionally, the cost-efficiency of the 'opt-out' default intervention is noteworthy. By leveraging existing cognitive biases and simplifying decision-making, financial institutions can implement these interventions with minimal additional cost compared to more traditional methods such as extensive financial education programs.

Regarding our second research question (RQ2), our analysis contradicts our expectations. Neither static nor dynamic peer norms yielded a significant main effect on enrollment decisions, suggesting that the presence of peer information nudges does not influence the probability of enrollment among the peer norm groups. Furthermore, the anticipated interaction between the default condition and peer information, as posited in RQ3, also did not materialize. This indicates that the increase in enrollment decision in the 'opt-out' condition is not dependent on the type of peer information (no info, SPN, or DPN) provided. This independence could imply that the decision to enroll in a roundup investing program is predominantly driven by the ease facilitated by the default option rather than social comparisons or normative trends.

These results contrast with the literature that often attributes a strong influence of social norms on financial behaviors (Banerjee & Das, 2023; Cialdini & Jacobson, 2021; Raue et al., 2020). The absence of an effect from peer information nudges on the enrollment behavior of young adults could be attributed to a complex interplay of social identity, (in)experience, trust, and contextual understanding. The broad categorization of 'other young adults', used in the vignette, might be too impersonal for individuals to feel a persuasive pull; social norms are more influential when the individual identifies with the in-group on a deeper level (Cialdini & Trost, 1998). This highlights the need for further research to explore how varying levels of in-group identification and contextual specificity influence the effectiveness of social norm nudges in similar interventions. While conformity bias typically drives individuals to align with their peers' actions (Cialdini & Trost, 1998), our findings suggest that this bias might be challenging to leverage in encouraging sound financial behaviors among emerging adults, pointing to the context dependency of nudge interventions (Dolan et al., 2012). Particularly in our young adult sample, the relatively low financial literacy (FL) scores ($M = 0.6$, $SD = 0.3$) and financial self-efficacy (FSE) ($M = 37.0$, $SD = 18.6$) could imply a self-awareness of their limited knowledge and abilities. Emerging adults with low FL and FSE may not only be aware of their own limitations but also distrust the financial competence of their peers, leading them to discount peer behaviors as a reliable source of guidance (Van Hoorn et al., 2017). This caution may stem from an understanding that their peers are likely to possess similar FL and FSE levels. This finding aligns with evidence from Beshears et al. (2015) and Dur et al. (2021).

Another possible reason for these findings can be ascribed to digital information overload, which might dilute the impact of any single source of peer information (Bawden & Robinson, 2020). Furthermore, the complexity of financial decisions may be particularly overwhelming for those with low FL and FSE, causing them to avoid engagement rather than

risk following potentially ill-informed peer actions (Menezes & Hanson, 1970). Finally, young adults' inexperience with investment products might instill a natural wariness or skepticism toward making financial commitments based on peer behavior. Prior research confirms that humans are naturally averse to the unknown, especially in a financial context (Cao et al., 2007). This skepticism might be compounded by a mistrust of financial institutions, with the credibility of the nudge's source playing a critical role in its acceptance (de Ridder et al., 2022; van der Cruijsen et al., 2023). These elements suggest that more personalized and context-rich approaches might be necessary to nudge this demographic effectively toward increased enrollment behaviors.

Concerning our last research question (RQ4), our data underscores the significant impact of financial literacy (FL) and financial self-efficacy (FSE) on enrollment decisions, as supported by prior research (Chowdhry & Dholakia, 2020; Lusardi & Messy, 2023).

Participants with higher FL and FSE were more likely to decide to enroll, underscoring the role of individual confidence and knowledge in financial decision-making. However, it is important to note that the effect size of the default condition was notably larger, with a medium effect size (Cohen's $d = .55$). In comparison, FL had a small to medium effect (Cohen's $d = .34$), while FSE had a very small effect (Cohen's $d = .005$).

Although not the primary focus of our study, our results reveal a small inverse relation between FSE and FL. This suggests a possible manifestation of the 'Dunning-Kruger effect,' which describes a tendency for incompetent individuals (low FL) to overestimate their ability (high FSE) (Kruger & Dunning, 1999). This intriguing aspect invites further investigation into the complex dynamics between financial confidence and knowledge, potentially indicating that overconfidence in one's financial abilities may inversely correlate with actual financial knowledge.

Limitations

Despite its practical nature, this study has several limitations. Firstly, the study focused on young adults within the Dutch-speaking region of Belgium, which may limit the generalizability of the findings to other geographical locations or cultural contexts. Different regions might have varying financial norms and levels of trust in financial institutions, which could affect the applicability of the results elsewhere.

Secondly, given that the study utilized a specific and rather novel financial product (roundup investing) as the investment vehicle, the findings might not fully translate to scenarios involving other types of investments or products. Participants' familiarity or comfort with the specific product, or lack thereof, could influence their decision-making, which may not be the case with other financial products.

Thirdly, the study's approach to peer information, either static or dynamic, might not capture the full spectrum of social influences that young adults experience. In real-life settings, peer influences can be more nuanced and variable, possibly involving more personalized and direct interactions that were not replicated in the study's design.

Additionally, the absence of manipulation checks or a valid measure of participant attentiveness, such as answering time, means it is unclear whether participants fully engaged with or understood the presented vignettes. This limitation raises questions about the reliability of responses and warrants further exploration in future studies.

Fourthly, while the study acknowledges the importance of the credibility of the nudge source, it did not specifically measure participants' perceptions of trust in banks or the credibility of the presented messages. Variations in perceived trust or credibility could substantially impact nudge effectiveness and should be a focus of future research.

Furthermore, the broad categorization of 'other young adults' as the peer group in the vignettes might have been too impersonal for participants to feel a persuasive pull. Social norms are

known to be more influential when individuals identify strongly with their in-group (Cialdini & Trost, 1998), suggesting a need for further research to explore the role of in-group identification in peer norm interventions.

Lastly, we used, but did not manipulate the temporal aspect of the vignettes (e.g. enroll now vs. enroll on 18th birthday). In the literature, such temporal manipulations, better known as the ‘fresh start effect’ have proven to be effective in triggering behavioral change (Beshears et al., 2021). Consequently, it's uncertain whether the noted effects manifest independently of such time-related signals. Further research is needed to isolate the influence of the fresh start effect by explicitly testing the impact of temporal landmarks on financial decision-making behaviors.

Implications for Theory, Practice, and Policy

The findings from this study offer tangible implications for both theory and practice, suggesting, albeit indirectly, that nudging interventions, operating sophisticated intuitive processes rather than mere System 1 biases (De Neys, 2023), can potentially impact complex and significant financial decisions within a digital context, extending the scarce literature on digital nudging with young adults (Hummel & Maedche, 2019; Mirsch et al., 2017). This could provide additional evidence for and extend the theoretical understanding that intuitive, fast-thinking processes, play a crucial role in the financial behavior of young adults, challenging traditional dual-process assumptions about the necessity of deliberative processing for advantageous financial choices (Voudouri et al., 2024). Our study's findings suggest that peer information exerts minimal to no influence on the financial decision-making of young adults, a demographic traditionally thought to be highly receptive to social cues (van Hoorn et al., 2016). This challenges current financial behavior models that overemphasize the role of peer effects (Banerjee & Das, 2023), indicating the need for a revised theoretical

approach that accounts for the autonomy of this group in digital financial contexts (Raue et al., 2020).

One actionable strategy for financial institutions could be the use of set-and-forget default nudges that automatically enroll emerging adults in a roundup investing program at a pivotal moment in the life cycle, leveraging both temporal landmarks (Dai et al., 2014) and the interplay between competing intuitions (Van Dessel et al., 2022) to positively influence their financial future. The practical success of roundup investing initiatives hinges not only on the effective deployment of nudges, but also on the inherent underlying structure and management of the investment options offered to young investors (Sarkar, 2020). Regulation should ensure they serve the best interests of the young clientele, providing them with fair, accessible, and cost-effective investment opportunities (Lusardi & Messy, 2023).

Additionally, opt-out default interventions are a cost-efficient addition to more traditional strategies, such as educational programs aimed at improving financial literacy or financial incentives (Fernandes et al., 2014), making them a viable and scalable solution for promoting financial inclusion and empowerment among young adults (Birkenmaier et al., 2022).

For policy, it is crucial to ensure that behavioral strategies are not only transparent (de Ridder et al., 2022; Hansen & Jespersen, 2013; Michels et al., 2021) but also account for the individual's capacity to contextualize and understand peer information (Cialdini & Jacobson, 2021). This is particularly important given emerging evidence that young adults may process social information differently in digital versus traditional contexts (Jain & Stuart, 2022).

Altogether, these insights advocate for a holistic approach that aligns theoretical understandings with practical applications and policy guidelines (Benartzi et al., 2017) to support young adults in their financial journeys.

Conclusion

In conclusion, this study contributes to the scarce literature on digital nudging in an applied, financial context with young adults. We find a significant and large effect of a set-and-forget opt-out default intervention and no influence of providing peer information (neither static nor dynamic) on the decision to enroll in a roundup investing program. We hereby contribute to our understanding of behavioral finance interventions in the real world and the subtle mechanics of nudging, reinforcing the necessity for comprehensive, context-sensitive approaches in fostering prudent financial behaviors among young adults. We provide valuable insights as a reference point for future research, policymakers, and practitioners.

References

- Alós-Ferrer, C., Hügelschäfer, S., & Li, J. (2016). Inertia and Decision Making. *Frontiers in Psychology*, 7. <https://www.frontiersin.org/articles/10.3389/fpsyg.2016.00169>
- Asch, S. E. (1956). Studies of independence and conformity: I. A minority of one against a unanimous majority. *Psychological Monographs: General and Applied*, 70(9), 1-70. <https://doi.org/10.1037/h0093718>
- Bakdash, J. Z., & Marusich, L. R. (2022). Left-truncated effects and overestimated meta-analytic means. *Proceedings of the National Academy of Sciences*, 119(31), e2203616119. <https://doi.org/10.1073/pnas.2203616119>
- Baker, C., & Odinet, C. K. (2023). *The Gamification of Banking* (SSRN Scholarly Paper No. 4568640). <https://papers.ssrn.com/abstract=4568640>
- Bandura, A. (1997). *Self-efficacy: The exercise of control* (pp. ix, 604). W H Freeman/Times Books/ Henry Holt & Co.
- Banerjee, P., & Das, T. (2023). *Peer Effects on Complex Financial Decisions* (SSRN Scholarly Paper No. 4557501). <https://doi.org/10.2139/ssrn.4557501>
- Bank of America. (2005). *Keep the Change® Savings Program*. <https://www.bankofamerica.com/deposits/keep-the-change/>
- Bawden, D., & Robinson, L. (2020). Information Overload: An Introduction. In *Oxford Research Encyclopedia of Politics*. <https://doi.org/10.1093/acrefore/9780190228637.013.1360>
- Bayuk, J., & Altobello, S. A. (2019). Can gamification improve financial behavior? The moderating role of app expertise. *International Journal of Bank Marketing*, 37(4), 951-975. <https://doi.org/10.1108/IJBM-04-2018-0086>
- Benartzi, S., Beshears, J., Milkman, K. L., Sunstein, C. R., Thaler, R. H., Shankar, M., Tucker-Ray, W., Congdon, W. J., & Galing, S. (2017). Should Governments Invest

- More in Nudging? *PSYCHOLOGICAL SCIENCE*, 28(8), 1041-1055.
<https://doi.org/10.1177/0956797617702501>
- Beshears, J., Choi, J. J., Laibson, D., & Madrian, B. C. (2009). The Importance of Default Options for Retirement Saving Outcomes: Evidence from the United States. *NBER Chapters*, 167-195.
- Beshears, J., Choi, J. J., Laibson, D., Madrian, B. C., & Milkman, K. L. (2015). The Effect of Providing Peer Information on Retirement Savings Decisions. *The Journal of Finance*, 70(3), 1161-1201. <https://doi.org/10.1111/jofi.12258>
- Birkenmaier, J., Maynard, B., & Kim, Y. (2019). PROTOCOL: Interventions designed to improve financial capability by improving financial behavior and financial access: A systematic review. *Campbell Systematic Reviews*, 15(1-2), e1020.
<https://doi.org/10.1002/cl2.1020>
- Birkenmaier, J., Maynard, B., & Kim, Y. (2022). Interventions designed to improve financial capability: A systematic review. *Campbell Systematic Reviews*, 18(1), e1225.
<https://doi.org/10.1002/cl2.1225>
- Braams, B. R., Davidow, J. Y., & Somerville, L. H. (2019). Developmental patterns of change in the influence of safe and risky peer choices on risky decision-making. *Developmental Science*, 22(1), e12717. <https://doi.org/10.1111/desc.12717>
- Broby, D. (2021). Financial technology and the future of banking. *Financial Innovation*, 7(1), 47. <https://doi.org/10.1186/s40854-021-00264-y>
- Cao, H. H., Han, B., Zhang, H. H., & Hirshleifer, D. A. (2007). *Fear of the Unknown: Familiarity and Economic Decisions* (SSRN Scholarly Paper No. 985381).
<https://doi.org/10.2139/ssrn.985381>
- Chapman, L. E., Sadeghzadeh, C., Koutlas, M., Zimmer, C., & Marco, M. D. (2019). Evaluation of three behavioural economics ‘nudges’ on grocery and convenience store

- sales of promoted nutritious foods. *Public Health Nutrition*, 22(17), 3250-3260.
<https://doi.org/10.1017/S1368980019001794>
- Chen, M. A., Wu, Q., & Yang, B. (2019). How Valuable Is FinTech Innovation? *The Review of Financial Studies*, 32(5), 2062-2106. <https://doi.org/10.1093/rfs/hhy130>
- Cheng, L., Hao, M., Xiao, L., & Wang, F. (2022). Join us: Dynamic norms encourage women to pursue STEM. *Current Psychology*, 41(9), 5967-5977.
<https://doi.org/10.1007/s12144-020-01105-4>
- Choukhmane, T. (2024). *Default Options and Retirement Saving Dynamics*.
<https://tahachoukhmane.com/wp-content/uploads/2024/04/Choukhmane-2024-Default-options.pdf>
- Chowdhry, N., & Dholakia, U. M. (2020). Know thyself financially: How financial self-awareness can benefit consumers and financial advisors. *FINANCIAL PLANNING REVIEW*, 3(1), e1069. <https://doi.org/10.1002/cfp2.1069>
- Cialdini, R. B., & Jacobson, R. P. (2021). Influences of social norms on climate change-related behaviors. *Current Opinion in Behavioral Sciences*, 42, 1-8.
<https://doi.org/10.1016/j.cobeha.2021.01.005>
- Cialdini, R. B., Reno, R. R., & Kallgren, C. A. (1990). A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. *Journal of Personality and Social Psychology*, 58(6), 1015-1026. <https://doi.org/10.1037/0022-3514.58.6.1015>
- Cialdini, R. B., & Trost, M. R. (1998). Social influence: Social norms, conformity and compliance. In *The handbook of social psychology*, Vols. 1-2, 4th ed (pp. 151-192). McGraw-Hill.

Clark, G. L., Strauss, K., & Knox-Hayes, J. (2012). *Saving for Retirement: Intention, Context, and Behavior*. Oxford University Press.

<https://doi.org/10.1093/acprof:oso/9780199600854.001.0001>

Cole, S., Sampson, T., & Zia, B. (2009). *Financial Literacy , Financial Decisions , and the Demand for Financial Services: Evidence from India and Indonesia*.

<https://www.semanticscholar.org/paper/Financial-Literacy-%2C-Financial-Decisions-%2C-and-the-Cole-Sampson/fddc0669faf6325d854f8e67b166ce826b5c5c75>

Conner, M., & Norman, P. (2022). Understanding the intention-behavior gap: The role of intention strength. *Frontiers in Psychology*, 13.

<https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2022.923464>

Costa, D. L., & Kahn, M. E. (2010). *Energy Conservation “Nudges” and Environmentalist Ideology: Evidence from a Randomized Residential Electricity Field Experiment* (Working Paper No. 15939). National Bureau of Economic Research.

<https://doi.org/10.3386/w15939>

Dai, H., Milkman, K. L., & Riis, J. (2014). The Fresh Start Effect: Temporal Landmarks Motivate Aspirational Behavior. *Management Science*, 60(10), 2563-2582.

<https://doi.org/10.1287/mnsc.2014.1901>

De Neys, W. (2021). On Dual- and Single-Process Models of Thinking. *Perspectives on Psychological Science*, 16(6), 1412-1427. <https://doi.org/10.1177/1745691620964172>

De Neys, W. (2022). Advancing theorizing about fast-and-slow thinking. *The Behavioral and Brain Sciences*, 46, e111. <https://doi.org/10.1017/S0140525X2200142X>

De Neys, W. (2023). Further advancing fast-and-slow theorizing. *Behavioral and Brain Sciences*, 46, e146. <https://doi.org/10.1017/S0140525X23000559>

- de Ridder, D., Kroese, F., & van Gestel, L. (2022). Nudgeability: Mapping Conditions of Susceptibility to Nudge Influence. *Perspectives on Psychological Science*, 17(2), 346-359. <https://doi.org/10.1177/1745691621995183>
- Dinner, I., Johnson, E. J., Goldstein, D. G., & Liu, K. (2011). Partitioning default effects: Why people choose not to choose. *Journal of Experimental Psychology: Applied*, 17, 332-341. <https://doi.org/10.1037/a0024354>
- Dolan, P., Elliott, A., Metcalfe, R., & Vlaev, I. (2012). Influencing Financial Behavior: From Changing Minds to Changing Contexts. *Journal of Behavioral Finance*, 13(2), 126-142. <https://doi.org/10.1080/15427560.2012.680995>
- Dur, R., Fleming, D., van Garderen, M., & van Lent, M. (2021). A social norm nudge to save more: A field experiment at a retail bank. *Journal of Public Economics*, 200, 104443. <https://doi.org/10.1016/j.jpubeco.2021.104443>
- Evans, J. (2008). Dual-Processing Accounts of Reasoning, Judgment, and Social Cognition. *Annual Review of Psychology*, 59(1), 255-278. <https://doi.org/10.1146/annurev.psych.59.103006.093629>
- Faour, A., & Al-Sowaidi, A. S. S. S. (2023). Fintech Revolution: How Established Banks Are Embracing Innovation to Stay Competitive. *Journal of Business and Management Studies*, 5(5), Article 5. <https://doi.org/10.32996/jbms.2023.5.5.14>
- Fernandes, D., Lynch, J. G., & Netemeyer, R. G. (2014). Financial Literacy, Financial Education, and Downstream Financial Behaviors. *Management Science*, 60(8), 1861-1883.
- Festinger, L. (1954). *A Theory of Social Comparison Processes*. 7(2), 117-140.
- Gal, D. (2006). A psychological law of inertia and the illusion of loss aversion. *Judgment and Decision Making*, 1(1), 23-32. <https://doi.org/10.1017/S1930297500000322>

Gargano, A. (2021). *Correcting Present Bias in Saving Decisions with FinTech**.

<https://www.semanticscholar.org/paper/Correcting-Present-Bias-in-Saving-Decisions-with-Gargano/2b71023b5b0c574f5ebd2d2cb59d18b711eb6e5f>

Geber, S., Tribelhorn, L., Hitchman, S. C., & Friemel, T. N. (2022). Dynamic norms for dynamic times? An experiment on the effects of dynamic and static norms messages on COVID-19 vaccination intention. *SCM Studies in Communication and Media*, 11(3), Article 3. <https://doi.org/10.5771/2192-4007-2022-3-453>

Goda, G. S., & Flaherty Manchester, C. (2010). *Incorporating Employee Heterogeneity into Default Rules for Retirement Plan Selection* (Working Paper No. 16099). National Bureau of Economic Research. <https://doi.org/10.3386/w16099>

Godefroid, M.-E., Plattfaut, R., & Niehaves, B. (2023). How to measure the status quo bias? A review of current literature. *Management Review Quarterly*, 73(4), 1667-1711. <https://doi.org/10.1007/s11301-022-00283-8>

Graupensperger, S., Abdallah, D. A., & Lee, C. M. (2021). Social norms and vaccine uptake: College students' COVID vaccination intentions, attitudes, and estimated peer norms and comparisons with influenza vaccine. *Vaccine*, 39(15), 2060-2067. <https://doi.org/10.1016/j.vaccine.2021.03.018>

Hansen, P. G., & Jespersen, A. M. (2013). Nudge and the Manipulation of Choice: A Framework for the Responsible Use of the Nudge Approach to Behaviour Change in Public Policy. *European Journal of Risk Regulation*, 4(1), 3-28. <https://doi.org/10.1017/S1867299X00002762>

Horton, C., Darko, M., & Aldrich, E. (2024, april 3). *Best Money Saving Apps Of March 2024* – *Forbes Advisor*. <https://www.forbes.com/advisor/banking/savings/best-money-saving-apps/>

- Hosmer, D. W., & Lemeshow. (2013). Interpretation of the Fitted Logistic Regression Model. In *Applied Logistic Regression* (pp. 49-88). John Wiley & Sons, Ltd.
<https://doi.org/10.1002/9781118548387.ch3>
- Hummel, D., & Maedche, A. (2019). How effective is nudging? A quantitative review on the effect sizes and limits of empirical nudging studies. *Journal of Behavioral and Experimental Economics*, 80, 47-58. <https://doi.org/10.1016/j.socec.2019.03.005>
- Jain, A., & Stuart. (2022). Young Consumer Conformity and Identity Amplified by Social Media: Marketing Applications. *Journal of Student Research*, 11(3).
<https://doi.org/10.47611/jsrhs.v11i3.3491>
- Johan, I., Rowlingson, K., & Appleyard, L. (2021). The Effect of Personal Finance Education on The Financial Knowledge, Attitudes and Behaviour of University Students in Indonesia. *Journal of Family and Economic Issues*, 42(2), 351-367.
<https://doi.org/10.1007/s10834-020-09721-9>
- Johnson, E. J., & Goldstein, D. (2003). Do Defaults Save Lives? *Science*, 302(5649), 1338-1339. <https://doi.org/10.1126/science.1091721>
- Kahneman, D. (2003). Maps of Bounded Rationality: Psychology for Behavioral Economics. *American Economic Review*, 93(5), 1449-1475.
<https://doi.org/10.1257/000282803322655392>
- Kahneman, D. (2011). *Thinking, fast and slow*. Farrar, Straus and Giroux.
- Kahneman, D., & Tversky, A. (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica*, 47(2), 263-291. <https://doi.org/10.2307/1914185>
- Kaiser, T., Lusardi, A., Menkhoff, L., & Urban, C. J. (2020). *Financial Education Affects Financial Knowledge and Downstream Behaviors* (Working Paper No. 27057). National Bureau of Economic Research. <https://doi.org/10.3386/w27057>

- Kaiser, T., & Menkhoff, L. (2017). *Does Financial Education Impact Financial Literacy and Financial Behavior, and If so, When?* (SSRN Scholarly Paper No. 2753510). Social Science Research Network. <https://doi.org/10.2139/ssrn.2753510>
- Kaustia, M., & Knüpfer, S. (2011). *Peer Performance and Stock Market Entry* (SSRN Scholarly Paper No. 1359006). <https://doi.org/10.2139/ssrn.1359006>
- Kelting, K., Robinson, S., & Lutz, R. J. (2019). Would You Like to Round Up and Donate the Difference? Roundup Requests Reduce the Perceived Pain of Donating. *Journal of Consumer Psychology*, 29(1), 70-78. <https://doi.org/10.1002/jcpy.1064>
- Krishnan, S. (2014). *The Power of Mobile Banking: How to Profit from the Revolution in Retail Financial Services*. John Wiley & Sons.
- Kruger, J., & Dunning, D. (1999). Unskilled and unaware of it: How difficulties in recognizing one's own incompetence lead to inflated self-assessments. *Journal of Personality and Social Psychology*, 77(6), 1121-1134. <https://doi.org/10.1037/0022-3514.77.6.1121>
- Kuchler, T., & Stroebe, J. (2021). Social Finance. *Annual Review of Financial Economics*, 13(Volume 13, 2021), 37-55. <https://doi.org/10.1146/annurev-financial-101320-062446>
- Laursen, B., & Veenstra, R. (2021). Toward understanding the functions of peer influence: A summary and synthesis of recent empirical research. *Journal of Research on Adolescence*, 31(4), 889-907. <https://doi.org/10.1111/jora.12606>
- LeBaron, A. B., & Kelley, H. H. (2021). Financial Socialization: A Decade in Review. *Journal of Family and Economic Issues*, 42(1), 195-206. <https://doi.org/10.1007/s10834-020-09736-2>

- Lee, S. K. (2019). *Fintech Nudges: Overspending Messages and Personal Finance Management* (SSRN Scholarly Paper No. 3390777).
<https://doi.org/10.2139/ssrn.3390777>
- Lown, J. M. (2011). *Development and Validation of a Financial Self-Efficacy Scale* (SSRN Scholarly Paper No. 2006665). <https://papers.ssrn.com/abstract=2006665>
- Lusardi, A., & Messy, F.-A. (2023). The importance of financial literacy and its impact on financial wellbeing. *Journal of Financial Literacy and Wellbeing*, 1(1), 1-11.
<https://doi.org/10.1017/flw.2023.8>
- Lusardi, A., & Mitchell, O. S. (2011). *Financial Literacy and Planning: Implications for Retirement Wellbeing* (Working Paper No. 17078). National Bureau of Economic Research. <https://doi.org/10.3386/w17078>
- Luukkanen, L., & Uusitalo, O. (2019). Toward Financial Capability—Empowering the Young. *Journal of Consumer Affairs*, 53(2), 263-295.
<https://doi.org/10.1111/joca.12186>
- Maddux, J. E. (1995). Self-Efficacy Theory. In J. E. Maddux (Red.), *Self-Efficacy, Adaptation, and Adjustment: Theory, Research, and Application* (pp. 3-33). Springer US. https://doi.org/10.1007/978-1-4419-6868-5_1
- Maier, M., Bartoš, F., Stanley, T. D., Shanks, D. R., Harris, A. J. L., & Wagenmakers, E.-J. (2022). No evidence for nudging after adjusting for publication bias. *Proceedings of the National Academy of Sciences*, 119(31), e2200300119.
<https://doi.org/10.1073/pnas.2200300119>
- Mamidala, V., Kumari, P., & Singh, D. (2023). Should I invest or not? Investigating the role of biases and status quo. *Qualitative Research in Financial Markets, ahead-of-print*(ahead-of-print). <https://doi.org/10.1108/QRFM-12-2022-0198>

- Mancini, A., Desiderio, A., Di Clemente, R., & Cimini, G. (2022). Self-induced consensus of Reddit users to characterise the GameStop short squeeze. *Scientific Reports*, 12(1), 13780. <https://doi.org/10.1038/s41598-022-17925-2>
- Mandell, L., & Klein, L. S. (2009). The impact of financial literacy education on subsequent financial behavior. *Journal of Financial Counseling and Planning*, 20(1), 15-24.
- Menard, M. (2017). *So Many Courses, So Little Progress: Why Financial Education Doesn't Work - And What Does* (SSRN Scholarly Paper No. 3098279). <https://doi.org/10.2139/ssrn.3098279>
- Menezes, C. F., & Hanson, D. L. (1970). On the Theory of Risk Aversion. *International Economic Review*, 11(3), 481-487. <https://doi.org/10.2307/2525326>
- Mertens, S., Herberz, M., Hahnel, U. J. J., & Brosch, T. (2022). The effectiveness of nudging: A meta-analysis of choice architecture interventions across behavioral domains. *Proceedings of the National Academy of Sciences of the United States of America*, 119(1), e2107346118. <https://doi.org/10.1073/pnas.2107346118>
- Miah, M. (2023). The Role of Fintech in Bridging the Divide for Economic Empowerment. *Economics and Business*, 37(1), 206-219.
- Michels, L., Schmitt, K., Ochmann, J., Laumer, S., & Tiefenbeck, V. (2021, juni 11). *Is It All About Transparency? The Effectiveness and Ethics of a Digital Salience Nudge*.
- Milkman, K. L., Beshears, J., Choi, J. J., Laibson, D., & Madrian, B. C. (2011). Using implementation intentions prompts to enhance influenza vaccination rates. *Proceedings of the National Academy of Sciences*, 108(26), 10415-10420. <https://doi.org/10.1073/pnas.1103170108>
- Mirsch, T., Lehrer, C., & Jung, R. (2017). Digital Nudging: Altering User Behavior in Digital Environments. *Wirtschaftsinformatik 2017 Proceedings*. <https://aisel.aisnet.org/wi2017/track06/paper/4>

- Mitchell, O., & Lusardi, A. (2011). *Financial Literacy: Implications for Retirement Security and the Financial Marketplace* [OUP Catalogue]. Oxford University Press.
<https://econpapers.repec.org/bookchap/oxpobooks/9780199696819.htm>
- Monteith, S., & Glenn, T. (2016). Automated Decision-Making and Big Data: Concerns for People With Mental Illness. *Current Psychiatry Reports*, 18(12), 112.
<https://doi.org/10.1007/s11920-016-0746-6>
- Moscovici, S., Lage, E., & Naffrechoux, M. (1969). Influence of a Consistent Minority on the Responses of a Majority in a Color Perception Task. *Sociometry*, 32(4), 365-380.
<https://doi.org/10.2307/2786541>
- Muchnik, L., Aral, S., & Taylor, S. J. (2013). Social Influence Bias: A Randomized Experiment. *Science*, 341(6146), 647-651. <https://doi.org/10.1126/science.1240466>
- Niemiec, R. M., Champine, V., Vaske, J. J., & Mertens, A. (2020). Does the Impact of Norms Vary by Type of Norm and Type of Conservation Behavior? A Meta-Analysis. *Society & Natural Resources*, 33(8), 1024-1040.
<https://doi.org/10.1080/08941920.2020.1729912>
- Nolan, J. M., Schultz, P. W., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2008). Normative Social Influence is Underdetected. *Personality and Social Psychology Bulletin*, 34(7), 913-923. <https://doi.org/10.1177/0146167208316691>
- O'Donoghue, T., & Rabin, M. (2015). Present Bias: Lessons Learned and to Be Learned. *American Economic Review*, 105(5), 273-279. <https://doi.org/10.1257/aer.p20151085>
- OECD. (2017). *PISA 2015 Results (Volume IV): Students' Financial Literacy*. Organisation for Economic Co-operation and Development. https://www.oecd-ilibrary.org/education/pisa-2015-results-volume-iv_9789264270282-en

- OECD. (2018). *PISA 2018 Results, Percentage of students at each level of proficiency in financial literacy* (No. PISA Database, Table IV.B1.2.4.) [Dataset].
<https://doi.org/10.1787/888934123330>
- Pak, T.-Y., Fan, L., & Chatterjee, S. (2023). Financial socialization and financial well-being in early adulthood: The mediating role of financial capability. *Family Relations*, *n/a*(*n/a*). <https://doi.org/10.1111/fare.12959>
- Raue, M., D'Ambrosio, L. A., & Coughlin, J. F. (2020). The Power of Peers: Prompting Savings Behavior Through Social Comparison. *Journal of Behavioral Finance*, *21*(1), 1-13. <https://doi.org/10.1080/15427560.2019.1587762>
- Rawlings, E. D. (2020). Do you know what's in those cookies? An analysis of the readability of social media cookie policies. *Proceedings of the Association for Information Science and Technology*, *57*(1), e300. <https://doi.org/10.1002/pra2.300>
- Read, D., Loewenstein, G., & Rabin, M. (1999). Choice Bracketing. *Journal of Risk and Uncertainty*, *19*(1), 171-197. <https://doi.org/10.1023/A:1007879411489>
- Rhodes, N., Shulman, H. C., & McClaran, N. (2020). Changing Norms: A Meta-Analytic Integration of Research on Social Norms Appeals. *Human Communication Research*, *46*(2-3), 161-191. <https://doi.org/10.1093/hcr/hqz023>
- Rieger, M. O. (2020). How to Measure Financial Literacy? *Journal of Risk and Financial Management*, *13*(12), Article 12. <https://doi.org/10.3390/jrfm13120324>
- Robalino, J. D., Fishbane, A., Goldstein, D. G., & Hershfield, H. E. (2023). Saving for retirement: A real-world test of whether seeing photos of one's future self encourages contributions. *Behavioral Science & Policy*, *9*(1), 1-9.
<https://doi.org/10.1177/23794607231190607>
- Rooij, M., & Favela, L. H. (2016). A Nonlinear Dynamical Systems Theory Perspective on Dual-Processing Accounts of Decision-Making under Uncertainty. *Cognitive Science*.

- <https://www.semanticscholar.org/paper/A-Nonlinear-Dynamical-Systems-Theory-Perspective-on-Rooij-Favela/896cc9b358672dfea338fc8a6b01432fdb28441c>
- Samuelson, W., & Zeckhauser, R. (1988). Status quo bias in decision making. *Journal of Risk and Uncertainty*, 1(1), 7-59. <https://doi.org/10.1007/BF00055564>
- Sardar, S., & Anjaria, K. (2023). THE FUTURE OF BANKING: HOW NEO BANKS ARE CHANGING THE INDUSTRY. *International Journal of Management, Public Policy and Research*, 2(2), 32-41. <https://doi.org/10.55829/ijmpr.v2i2.153>
- Sarkar, S. (2020). *Consumer Expectations and Consumer Protection* (SSRN Scholarly Paper No. 3667910). <https://papers.ssrn.com/abstract=3667910>
- Schneider, C., Weinmann, M., & vom Brocke, J. (2017). *Digital Nudging—Guiding Choices by Using Interface Design* (SSRN Scholarly Paper No. 3052192). <https://papers.ssrn.com/abstract=3052192>
- Shanks, T. R. W., Mandell, L., & Adams, D. (2013). Financial Education and Financial Access: Lessons Learned from Child Development Account Research. *Innovations: Technology, Governance, Globalization*, 8(1-2), 159-175. https://doi.org/10.1162/INOV_a_00171
- Sheeran, P., & Webb, T. L. (2016). The Intention–Behavior Gap. *Social and Personality Psychology Compass*, 10(9), 503-518. <https://doi.org/10.1111/spc3.12265>
- Singh, S., Sahni, M. M., & Kovid, R. K. (2020). What drives FinTech adoption? A multi-method evaluation using an adapted technology acceptance model. *Management Decision*, 58(8), 1675-1697. <https://doi.org/10.1108/MD-09-2019-1318>
- Sparkman, G., & Walton, G. M. (2017). Dynamic Norms Promote Sustainable Behavior, Even if It Is Counternormative. *Psychological Science*, 28(11), 1663-1674. <https://doi.org/10.1177/0956797617719950>

- Sparkman, G., & Walton, G. M. (2019). Witnessing change: Dynamic norms help resolve diverse barriers to personal change. *Journal of Experimental Social Psychology*, 82, 238-252. <https://doi.org/10.1016/j.jesp.2019.01.007>
- Stetzka, R. M. (2024). Bounded Irrationality: A New Perspective on Economic Behavior. *Review of Behavioral Economics*, 11(1), 1-42. <https://doi.org/10.1561/105.00000179>
- Sunstein, C. R. (2019). On Freedom. In *On Freedom*. Princeton University Press. <https://doi.org/10.1515/9780691192024>
- Szaszi, B., Higney, A., Charlton, A., Gelman, A., Ziano, I., Aczel, B., Goldstein, D. G., Yeager, D. S., & Tipton, E. (2022). No reason to expect large and consistent effects of nudge interventions. *Proceedings of the National Academy of Sciences*, 119(31), e2200732119. <https://doi.org/10.1073/pnas.2200732119>
- Thaler, R. H., & Benartzi, S. (2004). Save More Tomorrow™: Using Behavioral Economics to Increase Employee Saving. *Journal of Political Economy*, 112(S1), S164-S187. <https://doi.org/10.1086/380085>
- Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decisions about health, wealth, and happiness* (pp. x, 293). Yale University Press.
- Thompson, J. (2019, augustus 30). How Bank of America Pioneered Roundup Savings [Blackrock Emergency Savings Initiative]. *Savings Project*. <https://savingsproject.org/keep-the-change-how-bank-of-america-pioneered-roundup-savings/>
- Totenhagen, C. J., Casper, D. M., Faber, K. M., Bosch, L. A., Wiggs, C. B., & Borden, L. M. (2015). Youth Financial Literacy: A Review of Key Considerations and Promising Delivery Methods. *Journal of Family and Economic Issues*, 36(2), 167-191. <https://doi.org/10.1007/s10834-014-9397-0>

- Uribe-Linares, G. P., Ríos-Lama, C. A., & Vargas-Merino, J. A. (2023). Is There an Impact of Digital Transformation on Consumer Behaviour? An Empirical Study in the Financial Sector. *Economies*, 11(5), Article 5. <https://doi.org/10.3390/economies11050132>
- van der Crujisen, C., de Haan, J., & Roerink, R. (2023). Trust in financial institutions: A survey. *Journal of Economic Surveys*, 37(4), 1214-1254. <https://doi.org/10.1111/joes.12468>
- Van Dessel, P., Boddez, Y., & Hughes, S. (2022). Nudging societally relevant behavior by promoting cognitive inferences. *Scientific Reports*, 12(1), Article 1. <https://doi.org/10.1038/s41598-022-12964-1>
- Van Hoorn, J., Crone, E. A., & Van Leijenhorst, L. (2017). Hanging Out With the Right Crowd: Peer Influence on Risk-Taking Behavior in Adolescence. *Journal of Research on Adolescence*, 27(1), 189-200. <https://doi.org/10.1111/jora.12265>
- van Hoorn, J., van Dijk, E., Meuwese, R., Rieffe, C., & Crone, E. A. (2016). Peer Influence on Prosocial Behavior in Adolescence. *Journal of Research on Adolescence*, 26(1), 90-100. <https://doi.org/10.1111/jora.12173>
- Vosylis, R., & Klimstra, T. (2022). How Does Financial Life Shape Emerging Adulthood? Short-Term Longitudinal Associations Between Perceived Features of Emerging Adulthood, Financial Behaviors, and Financial Well-Being. *Emerging Adulthood*, 10(1), 90-108. <https://doi.org/10.1177/2167696820908970>
- Voudouri, A., Białek, M., & De Neys, W. (2024). Fast & slow decisions under risk: Intuition rather than deliberation drives advantageous choices. *Cognition*, 250, 105837. <https://doi.org/10.1016/j.cognition.2024.105837>
- Weinmann, M., Schneider, C., & Brocke, J. vom. (2016). Digital Nudging. *Business & Information Systems Engineering*, 58(6), 433-436. <https://doi.org/10.1007/s12599-016-0453-1>

Xiao, J. J., & Porto, N. (2019). Present bias and financial behavior. *FINANCIAL PLANNING REVIEW*, 2(2), e1048. <https://doi.org/10.1002/cfp2.1048>

Zhao, W. J., Coady, A., & Bhatia, S. (2022). Computational mechanisms for context-based behavioral interventions: A large-scale analysis. *Proceedings of the National Academy of Sciences*, 119(15), e2114914119. <https://doi.org/10.1073/pnas.2114914119>

Supplementary Information

Table S1

Correlation matrix

	1	2	3	4
1 Enrollment decision				
2 Financial self-efficacy	.046			
3 Financial literacy	.096**	-.195**		
4 Gender	-.082**	.017	-.224**	
5 Default condition	.253**	.008	.010	-.026

Note. * $p < .050$, ** $p < .010$, *** $p < .001$. For correlations between two categorical variables, point-biserial correlations are presented. For correlations between two continuous variables, Pearson correlations are presented. The default condition variable is coded as 0 for opt-in (reference category) and 1 for opt-out. The Gender variable is coded as 0 for female (reference category) and 1 for male.

Conditions

Dutch – English (translated for publication, not administered)

	Basis vignette, identiek voor elke conditie	Base vignette, identical for all conditions
	Stel je de volgende situatie voor: Over een maand word je 18 jaar. Omdat je weldra volwassen wordt, stuurt je bank onderstaande email met de vraag om om een belangrijke keuze te maken met betrekking tot de voorkeuren van jouw bankrekening voor volwassenen: Proficiat met je 18de verjaardag! Een goed moment om te beginnen beleggen met je wisselgeld.  Proficiat! Binnenkort word je 18 jaar. Volwassen worden komt met heel wat veranderingen, ook voor je bankzaken. Nu je bijna volwassen bent kan je ervoor kiezen om te beginnen beleggen met je wisselgeld. Daarmee beleg je automatisch kleine bedragen elke keer als je betaalt met je zichtrekening. Zo beleg je gemiddeld zo'n 20 euro per maand. Dagelijks doe je verschillende uitgaven en betalingen met je rekening. Als je kiest voor beleggen met je wisselgeld, ronden we die bedragen af naar de eerstvolgende euro. Zodra je aan 10 euro komt, storten we die automatisch in je beleggingsplan. Zo beleg je zonder al te grote impact op je portefeuille of je levensstijl. Een voorbeeld: betaal je 3,51 euro bij de bakker? Dan gaat er 4 euro van je rekening, en daarvan 49 cent naar je beleggingsplan. En dat voor elke uitgave (tenzij je rekening daardoor onder nul zou gaan). Je kunt op elk moment pauzeren of bijstorten.	Imagine the following situation: In a month you will turn 18 years old. As you will soon become an adult, your bank sends you the following email asking you to make an important decision with regards to your adult bank account preferences: Congratulations with your 18th birthday! A great time to start investing with your spare change.  Congratulations! Soon you will turn 18 years old. Being an adult comes with a lot of changes, also for your banking matters. Now you are becoming a grown-up, you can choose to start investing with your spare change. This means that you will automatically invest small amounts every time you pay with your checking account. On average, you invest about 20 euros per month. Every day you make various expenses and payments with your account. If you choose to invest with your spare change, we round up the amounts to the next euro. As soon as it reaches 10 euros, we automatically deposit it into your investment plan. This way, you invest without too much impact on your wallet or lifestyle. An example: When you pay 3.51 euros at the bakery, then 4 euros will be deducted from your account, and of that, 49 cents goes to your personal investment plan. And that's for every expense (unless your account would go below zero). You can pause or increase contributions at any time.
SPN	Al meer dan 90.000 andere jongeren beleggen al met hun wisselgeld. Omdat je belegt met kleine bedragen, is het als startende belegger een eenvoudige manier om te proeven van beleggen.	More than 90,000 other young adults are already investing with their spare change. Because you invest with small amounts, it is an easy way for beginning investors to get a taste of investing.
DPN	De laatste jaren is het aantal jongeren die belegt met wisselgeld sterk toegenomen. In 2020 kozen 18.000 jongeren voor de formule. In 2021 kozen 43.000 jongeren voor de formule. In 2022 kozen er al meer dan 90.000 andere jongeren om te beginnen beleggen met hun wisselgeld. Omdat je belegt met kleine bedragen, is het als startende belegger een eenvoudige manier om te proeven van beleggen.	The last few years, the number of young adults who choose to invest with their spare change has increased strongly. In 2020, 18,000 young adults chose to enroll. In 2021, 43,000 young adults chose to enroll. In 2022, more than 90,000 other young adults chose to start investing with their spare change. Because you invest with small amounts, it is an easy way for beginning investors to get a taste of investing.
Opt-in	☐ Indien je wenst te beleggen met jouw wisselgeld, volstaat het om het vakje aan te klikken. Op de dag dat je 18 jaar wordt, zal het programma automatisch van start gaan. Je hoeft dan geen verdere acties te ondernemen. Je kan op elk moment pauzeren, bijstorten of het programma stopzetten door de instellingen in je banking app aan te passen of contact op te nemen met je bank. Bevestig keuze	☐ If you wish to start to invest with your spare change, please check the box. On the day you actually turn 18, the program will start automatically. You won't have to take any further action. You can pause, add funds, or stop the program at any time by changing the settings in your banking app or by contacting your bank. Confirm choice
Opt-out	☐ We schrijven je automatisch in voor het programma. Indien je NIET wenst te beginnen met beleggen met je wisselgeld wanneer je 18 wordt, gelieve het vakje aan te vinken. Wanneer je het vakje aanvinkt, zal je NIET ingeschreven worden voor het programma 'Beleggen met wisselgeld'. Je kunt op elk moment beslissen om toch nog deel te nemen door deze functie in te schakelen in de instellingen van je banking app of door contact op te nemen met je bank. Bevestig keuze	☐ We will automatically enroll you in the program. If you DO NOT wish to start to invest with your spare change when you turn 18, please check the box. When you check the box, we will NOT automatically enroll you in the 'Investing with Spare Change' program. You can decide to participate at any time by enabling this feature in the settings of your banking app or by contacting your bank. Confirm choice

Note. SPN= Static peer norm; DPN= Dynamic Peer norm. Every participant received the same base vignette. Depending on the condition, they then received either no further information, SPN or DPN followed by an opt-in or opt-out enrollment prompt.

3

When Less Is More: The Effect of Temporal Reframing on Retirement Contributions

Mathias Celis, Mona Bassleer, Wouter Duyck, Kris Boudt, Bram Van Daele, and Nicolas Dirix.

Abstract

Despite mounting demographic pressures on pension systems and the increasing need for private retirement preparation, saving rates remain critically low, particularly among younger generations. This study investigates how temporal reframing of contributions in daily, weekly, or monthly amounts, combined with different reference points (social norms, numerical anchors, or none), affect retirement saving decisions among young adults ($N = 631$, $M_{\text{Age}} = 22.49$, $SD_{\text{Age}} = 5.84$). Results reveal that daily framing significantly increases projected monthly savings, outperforming the weekly frame by approximately 26.8% and the monthly frame by 17.2%. Contrary to established anchoring literature, both social norms and numerical anchors suppressed saving amounts compared to the control condition, suggesting that explicit reference points might trigger psychological reactance in private financial decisions. No significant interaction effects were found between temporal framing and reference points, indicating these mechanisms operate independently. While these interventions influenced contribution amounts, they did not affect participants' general willingness to implement similar decisions in real life, suggesting a dissociation between immediate choice architecture effects and broader financial attitudes. These findings advance our understanding of behavioral interventions in retirement savings and offer practical insights for financial advisors and policymakers seeking to address the retirement savings gap through choice architecture.

Statement of Relevance

Why do people consistently save too little for retirement, even when they have the means and understanding to do so? This research addresses one of society's most pressing challenges: the widening retirement savings gap. With life expectancy rising, fertility rates dropping, and pension systems under mounting pressure, younger generations need to save 40% more than their parents to maintain equivalent retirement security. Our findings demonstrate how framing contributions in daily rather than monthly amounts, can significantly increase retirement contributions. When compounded over time, these differences translate to potentially thousands of euros in additional retirement savings. Notably, we find that common practices such as social comparisons or numerical anchors might backfire, reducing rather than enhancing saving intentions. These insights provide financial institutions, advisors, and policymakers with immediately applicable tools to help young adults make better financial decisions while preserving their autonomy. As societies worldwide grapple with pension system sustainability, our research offers a practical, scalable approach to nudging individuals toward greater financial security, without resorting to costly incentives or mandatory measures.

Introduction

It is widely established that individuals frequently encounter challenges in managing long-term financial goals, particularly in the context of retirement savings (Laibson, 1997; Madrian & Shea, 2001; Thaler & Benartzi, 2004). Behavioral economic theories suggest that cognitive biases such as present bias and loss aversion undermine effective planning for the future (Beshears et al., 2009; Kahneman & Tversky, 1979; Thaler & Benartzi, 2004). The global rise in life expectancy, combined with plummeting fertility rates, further highlights these challenges (Lee & Mason, 2010; Oeppen & Vaupel, 2002). Since the early 19th century, life expectancy has doubled and now surpasses 80 years in most developed nations (OECD, 2024; Riley, 2005). Meanwhile, the European (EU) reproduction rate averages only 1.53 children per woman, well below the 2.1 replacement level needed for population stability (Eurostat, 2024). Consequently, by 2050, for every OECD retiree, there will be only 2.2 working-age individuals, compared to 3.7 today (OECD, 2023). Recent projections estimate that this trend will lower net income replacement ratios by 20-25% across OECD countries over the next three decades, requiring younger generations to save approximately 40% more than their parents to maintain equivalent retirement security (EU commission, 2023; OECD, 2023). Beyond demographic pressure, global pension systems face mounting fiscal challenges. Budgetary constraints and historically low interest rates have accelerated the erosion of traditional pension guarantees (Bayar, 2018; Bielecki et al., 2020). This transformation has shifted retirement planning responsibilities from institutions to individuals, raising fundamental concerns about pension system sustainability (Munnell et al., 2014; Munnell & Sass, 2008).

Yet, despite these alarming trends, current saving patterns fall dramatically short. In Belgium, the setting of our study and a representative OECD country, 64% of households are financially vulnerable or unhealthy, with more than half (54%) failing to save consistently

each month (Deloitte Belgium, 2023). Similar shortfall patterns are observed globally: across OECD countries, only 49% of working-age households save beyond mandatory systems, while nearly half would need to double their savings rate to maintain living standards in retirement (OECD, 2023). Despite the wide availability of various pension plans aimed at helping individuals hedge against financial insecurity, substantial structural and psychological barriers continue to obstruct effective retirement preparation (Benartzi et al., 2017; Mitchell & Lusardi, 2011).

One promising, yet understudied, potential solution to mitigate these barriers and encourage savings is to present larger financial contributions in smaller, more psychologically manageable denominations, over shorter time frames (Hershfield et al., 2020). This study explores whether reframing retirement contributions in daily, weekly, and monthly denominations can influence total contribution amounts. Furthermore, given that decisions about pensions are often made privately, despite the inherently social nature of human behavior, we will also investigate whether presenting a social anchor (based on peer norms) compared to a standard injunctive¹ anchor can further influence contribution amounts.

Temporal Reframing

Thaler's (1985) mental accounting theory suggests that people naturally organize their finances into distinct and non-fungible mental “accounts” based on specific time frames and spending categories, with each decision shaped by how easily an expense fits within these mental budgets. For example, consumers often treat their monthly coffee budget differently from their annual vacation savings, even though both represent discretionary spending. This process of categorization influences how people evaluate costs: when expenses are broken down into smaller, more frequent payments, they are more likely to be viewed as part of routine daily expenses, which feel more manageable and less restrictive (Jaber, 2010;

¹ A reference point or guideline suggesting the recommended behavior, indicating what individuals ought to do in a given context.

Markowitz, 1952). This tendency forms the basis for temporal reframing, a behavioral intervention that presents larger financial commitments as smaller, more regular contributions.

Also known in the literature as the “pennies-a-day” effect, temporal reframing leverages mental accounting by segmenting a large, potentially intimidating cost into smaller, routine payments. As such, people are more likely to categorize large expenses as a manageable commitment alongside other day-to-day expenses, lowering the perceived psychological and financial burden. Gourville (1998) pioneered the “pennies-a-day” effect in the context in charitable giving, showing that reframing donations as small, daily amounts (e.g., “just 50 cents a day”) rather than a larger yearly sum (e.g., \$180 per year) made contributions feel more manageable, and significantly boosted participation rates. Similarly, Bambauer-Sachse & Grewal (2011) found that reframing product prices into shorter, recurring payments, such as weekly or monthly amounts, increased perceived affordability and attractiveness, leading to higher purchase intentions in consumer contexts.

Despite its established effectiveness in consumer finance, the application of temporal reframing remains limited in the field of retirement savings, where psychological barriers, such as the reluctance to commit to long-term contributions, often deter participation (Benartzi & Thaler, 2013). When leveraged effectively, the pennies-a-day principle in retirement savings could unlock immense societal benefits; even modest increases of just a few percentage points in contributions can translate into billions of additional pension savings, significantly enhancing financial security for future generations. To our knowledge, Hershfield et al. (2020) and Shu et al. (2022) are the only studies that applied temporal reframing to retirement savings, finding that framing contributions as daily expenses rather than larger, infrequent payments led to a fourfold increase in enrollment. In the pension savings context, reframing annual contributions as daily or weekly denominations can

mitigate cognitive load, increase perceived affordability, and reduce the salience of loss, thus promoting higher enrollment rates in retirement savings plans (Hershfield et al., 2020; Shu et al., 2022; Thaler & Benartzi, 2004). These promising findings suggest that temporal reframing could play a critical role in improving retirement adequacy by reducing the perceived burden associated with substantial, long-term financial commitments.

(Social) Anchors

Decision-making seldom occurs in a vacuum. When individuals make choices, especially those involving complex or high-stakes financial decisions, they often rely on contextual cues to guide their thinking (Kahneman & Tversky, 1979; Simon, 1955). These cues, or anchors, act as initial reference points that shape subsequent judgments and behaviors, even when the anchors themselves are arbitrary (Chapman & Johnson, 1994; Tversky & Kahneman, 1974). Anchoring bias is one of the most robust cognitive biases identified in behavioral economics, with a recent meta-analysis revealing a large anchoring effect ($d = 0.88$) across various domains, including pricing, investment, and consumer choices (Schley, 2023).

Ariely et al. (2003) demonstrated this effect by showing how arbitrary numbers (participants' social security digits) influenced willingness to pay for products. Anchoring is particularly potent in financial contexts, where suggested donation amounts and recommended savings levels serve as reference points that guide commitment levels (Fraser et al., 1988; Thaler & Sunstein, 2008). In retirement planning, displaying higher "ideal" savings rates in retirement calculators (e.g., "\$80,000") creates a reference point that influences individuals' subsequent savings targets and contribution decisions (Mckenzie & Liersch, 2011).

Given that decisions about pensions are often made privately, despite the inherently social nature of human behavior, adding a social aspect to anchors can provide crucial

guidance in financial decision-making (Asch, 1956; Nolan et al., 2008). According to Festinger's (1954) social comparison theory, people have an innate drive to evaluate their opinions and actions by comparing themselves to (relevant) others. Empirical evidence supports the significance of peer effects in financial contexts; Duflo and Saez (2002, 2003) demonstrated peer influences on retirement saving outcomes, while Kubik et al. (2001) and Brown et al. (2008) found similar effects in stock market participation. Meta-analytical evidence by Hummel & Maedche (2019) further supports social reference interventions' effectiveness, with 20% median and 29% average effect sizes.

By observing peers' decisions, individuals can rely cognitive shortcuts, allowing them to quickly infer 'appropriate' choices without engaging in cognitively demanding evaluation processes (Kahneman, 2011). This tendency, known as conformity bias (Asch, 1956), becomes more pronounced in complex or uncertain situations such as pension decisions, where the brain's natural tendency is to seek patterns and simplify complex information (Banerjee & Das, 2023; Cialdini & Trost, 1998; Nolan et al., 2008).

In the context of retirement savings, providing a social normative anchor may encourage higher contributions through peer comparison (Bernheim, 1994; Duflo & Saez, 2002). For example, showing messages like 'employees like you save 12%' creates reference points that pull contribution rates upward (Mckenzie & Liersch, 2011).

The combined effect of temporal reframing with social and injunctive anchors has been underexplored in the context of retirement savings, where both psychological and social barriers often deter individuals from committing to long-term contributions (Madrian & Shea, 2001; Laibson, 1997). This study aims to examine whether framing contributions as smaller, routine payments, in combination with normal anchors or social anchors, can increase both enrollment and total contribution levels.

Current Study

The current study examines how temporal framing and anchoring interventions influence retirement savings decisions. Using an 3x3 experimental design, we test nine conditions, combining three different temporal frames (daily, weekly, monthly) with three anchor conditions (a social norm anchor, standard anchor, no anchor). Rather than focusing on binary enrollment decisions as in previous research (e.g., Hershfield et al., 2020), we employ a continuous measure allowing participants to specify their preferred contribution amount. Rather than simply asking participants if they wish to enroll, this study prompts them to specify how much they would like to contribute, framed either as daily, weekly, and monthly amounts, with the option to indicate 0. Using a continuous scale enhances cognitive engagement by encouraging participants to actively consider their commitment level, promoting a more reflective, deliberate approach rather than relying on automatic, default-driven responses (Kahneman, 2011). This granular decision structure allows participants to tailor their contributions more precisely. Binary choices often lead to ambiguity aversion, resulting in minimal contributions (Brown et al., 2013; Kahneman & Tversky, 1979). Hence, this approach enables a more nuanced understanding of how the interventions affect both the decision to save and the magnitude of committed contributions.

Our study simultaneously tests temporal frames and anchoring strategies, with the inclusion of a no-anchor control group allowing us to isolate the specific effects of each anchor type. This design thus provides a nuanced understanding of these mechanisms regarding influencing financial commitment in retirement planning. When controlled for age, sex, we aim to address the following research questions:

RQ1: What are the main effects of temporal reframing (i.e., day, week, month), and anchor conditions (i.e. social norm anchor, standard anchor, no anchor) on (1) monthly saving and (2) willingness to save?

RQ2: To what extent do anchor conditions (i.e., social norm anchor, standard anchor, no anchor) moderate the relationship between temporal reframing (i.e., day, week, month) and (1) monthly saving and (2) willingness to save?

Method

Participants

The sample consisted of 631 Dutch-speaking individuals (48.3% female) between 18 and 35 years old ($M = 22.49$, $SD = 5.84$). Participants were recruited through a non-probability snowball sampling technique via social media platforms (primarily Facebook) and in-person recruitment of random passersby. All study materials were presented in Dutch, and only native Dutch speakers were included in the final sample to ensure proper comprehension of the experimental materials. No incentive was provided for participation. All participants provided informed consent prior to taking part in the study.

To characterize our sample, we collected data on various individual characteristics including financial literacy, family financial socialization, employment status, salary, highest educational degree, and self-control. While these variables provide important insights into our sample's characteristics, only age and sex were used as covariates in our analyses. Descriptive statistics for all demographic and individual difference variables are presented in Table S1 and S2 of the Supplementary Materials.

Design and Procedure

This study employed a 3 (temporal frame: day/week/month) $\times$ 3 (reference point: control/social norm/anchor) between-subjects experimental design using vignettes. Upon visiting the study website, participants were presented with a general introduction explaining the voluntary and anonymous nature of the study, and that no incentive would be provided for participation.

After providing basic demographic information (age, sex, educational level), participants were randomly assigned by Qualtrics to one of the nine experimental conditions. Each participant was presented with a vignette that read (translated from Dutch): "Imagine the following situation: You recently met with a financial advisor to discuss strategies for optimizing your savings to reach your financial goals. After reviewing your current financial situation and running some calculations, the advisor suggests..." The precise ending varied by condition:

- No anchor (control) condition: "...setting aside a fixed amount between 0 and the maximum [€6/day, €42/week, or €180/month]."
- Social norm condition: "...like 78% of clients with the same financial profile as you, setting aside a fixed amount per day/week/month between 0 and the maximum (€6/day, €42/week, or €180/month)."
- Anchor condition: "...setting aside [€2.72/day, €19.04/week, or €82.50/month]."

All scenarios continued with: "The funds would be invested according to your personal risk profile. The amount will be automatically transferred [daily/weekly/monthly], eliminating the need for manual transactions. You maintain full flexibility to adjust, pause, or increase your contributions at any time."

The amounts used in the scenario were inspired by Belgium's pension savings context, which provides a tax advantage when citizens contribute between €990 and €1,350 annually to their pension savings funds. While these thresholds served as a starting point, we increased the upper ceiling to €2,190 to allow for greater statistical variation in participant responses. This also provides an opportunity to explore whether there is potential market interest in increasing the upper ceiling for tax-incentivized contributions.

To maintain consistency across conditions while accommodating the mathematical constraints of dividing €990 by days (365), weeks (52), or months (12), all amounts were presented with two decimal places.

Participants responded to two dependent measures: the amount they would be willing to save (a continuous slider ranging from 0 to the maximum amount for their temporal condition) and their willingness to save (7-point Likert scale from "Completely disagree" to "Completely agree"). For analysis purposes, all saving amounts were extrapolated to monthly values to facilitate comparison between conditions (daily amounts $\times 30.42$, weekly amounts $\times 4.35$). To avoid central tendency bias, scales all started at a default value of zero, and were presented from left to right.

Following the experimental task, participants completed additional measures including financial literacy, family financial socialization, and self-control scales. The entire questionnaire took approximately 5 minutes to complete.

Analyses

We conducted a multivariate linear regression with two dependent variables (monthly saving amount and willingness to save) and four predictors: temporal reframing (day/week/month), anchor conditions (a social norm anchor, standard anchor, no anchor), and age and sex as covariates. This 3×3 factorial design enabled us to test both main effects and interaction effects within a single comprehensive model, providing a more robust analysis than separate univariate tests would allow, as well as controlling for Type I errors that could arise in the latter.

The analysis proceeded in several stages. First, we examined multivariate effects using Wilks' Lambda criterion, which offers a robust assessment of overall predictor significance while accounting for correlations between dependent variables. For significant predictors, we conducted follow-up univariate tests for each dependent variable. Post-hoc analyses employed

Bonferroni-adjusted pairwise comparisons to control for family-wise error rate while detecting specific group differences. Given the balanced design with approximately equal group sizes, Cohen's d was calculated as an appropriate effect size measure (Cohen, 1988).

Ethical Considerations

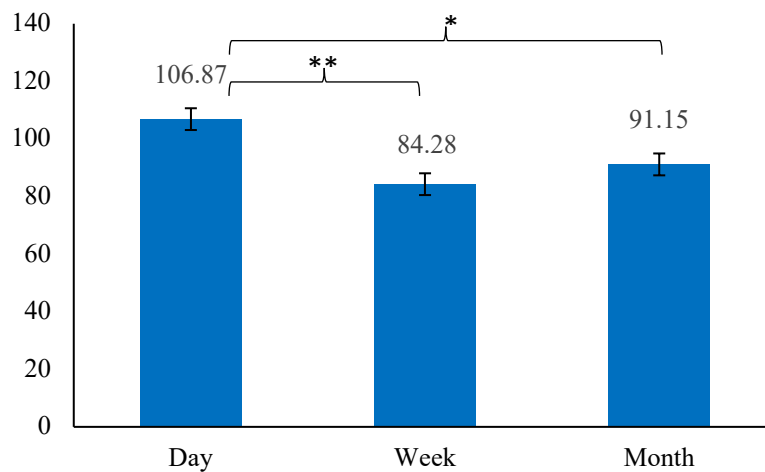
This study was conducted in accordance with the ethical guidelines for social science research. Participants were informed about the voluntary and anonymous nature of their participation at the outset of the online survey. No personally identifiable information was collected, and all data were stored securely on password-protected servers. As the study involved hypothetical financial decision-making scenarios with no potential for psychological or financial harm, and no vulnerable populations were targeted, it was classified as minimal risk research. No deception was used, and participants were free to withdraw at any time. No incentives were provided for participation, eliminating potential coercion concerns. The research protocol was reviewed and approved by the University ethical board and granted reference code 2021/138 FWO project nr.: S006721N.

Results

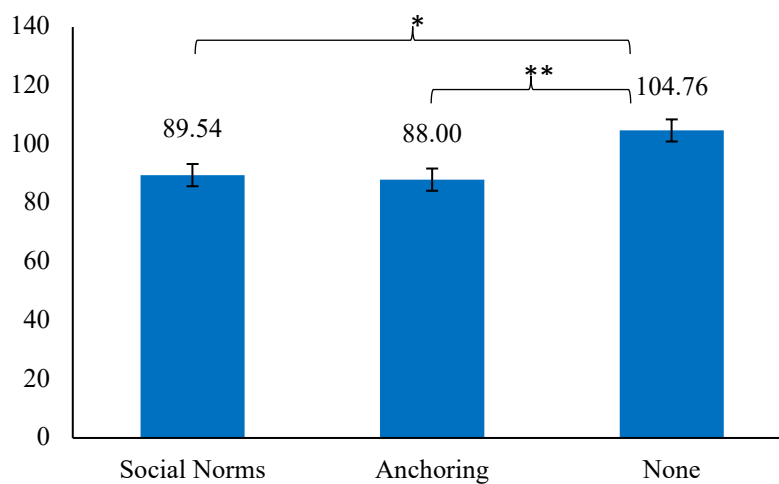
The (interaction) effect(s) are controlled for age, sex in the linear model. For RQ1, we investigated the main effects of temporal reframing (i.e., day, week, month), anchor conditions (a social norm anchor, standard anchor, no anchor) on (1) monthly saving and (2) willingness to save. First, the multivariate test shows a significant effect of both temporal reframing ($F(4, 1,238) = 4.82, p < .001$) as well as anchoring condition interventions ($F(4, 1,238) = 3.99, p = .003$), based on Wilks' Lambda. Second, the univariate tests for the prediction of monthly saving indicate a significant effect of temporal reframing ($F(2, 620) = 9.39, p < .001$; see Figure 1) and anchoring conditions ($F(2, 620) = 6.03, p = .003$; see Figure 2). Regarding the prediction of willingness to save, non-significant effects for temporal reframing ($F(2, 620) = 0.21, p = .811$) and anchoring conditions ($F(2, 620) = 2.56, p = .078$)

are found. Third, Bonferroni-adjusted Pairwise Comparisons show that the participants who were asked to report their saving intentions on a daily basis project a significantly higher mean monthly saving amount compared with those in the weekly ($|\Delta M| = 22.60, SD = 5.34, p < .001, d = 0.41$) and monthly ($|\Delta M| = 15.72, SD = 5.36, p = .011, d = 0.29$) conditions. Between the weekly and monthly conditions, the difference in mean monthly saving is non-significant ($|\Delta M| = 6.88, SD = 5.34, p = .599$). Additionally, we find that the mean monthly saving amount of the participants who did not receive an anchoring condition is higher than those in the social norms ($|\Delta M| = 15.22, SD = 5.35, p = .014, d = 0.28$) or anchoring conditions ($|\Delta M| = 16.77, SD = 5.35, p = .005, d = 0.31$). Between the social norms and anchoring conditions, the difference in mean monthly saving is non-significant ($|\Delta M| = 1.55, SD = 5.37, p > .050$).

For RQ2, the extent to which anchor condition (i.e. social norm anchor, standard anchor, no anchor) moderate the relationship between temporal reframing (i.e., day, week, month) and (1) monthly saving and (2) willingness to save was examined. Based on Wilks' Lambda, the multivariate test indicates a non-significant interaction effect between anchor condition and temporal reframing ($F(8, 1,238) = 1.33, p = .222$).

Figure 1*Estimated Marginal Means Monthly Saving per Temporal Framing Condition*

Note. $*p < .050$, $**p < .010$, $***p < .001$. Bonferroni-adjusted. Controlled for age, sex, and the other predictors in the model. The error bars represent the standard errors of the estimated marginal means.

Figure 2*Estimated Marginal Means Monthly Saving by Anchoring Condition*

Note. $*p < .050$, $**p < .010$, $***p < .001$. Bonferroni-adjusted. Controlled for age, sex, and the other predictors in the model. The error bars represent the standard errors of the estimated marginal means.

Discussion

This study examined how temporal framing (Day/Week/Month) and anchor conditions (a social norm anchor, standard anchor, no anchor) influence retirement savings decisions among adults, specifically investigating their effects on monthly saving amounts and willingness to save. Our findings reveal several notable patterns with significant theoretical and practical implications.

Temporal Framing Effects on Monthly Savings

Regarding temporal framing, our results demonstrate a significant main effect on aggregated monthly saving amounts. Daily framing of retirement contributions led to significantly higher aggregated monthly savings (€106.87) compared to both aggregated weekly (€84.28) and monthly frames (€91.15). When extrapolated annually, this amounts to a difference of €271.08 and €188.64 respectively, compounding to €4,068.20 and €2,829.60 over a 15-year period.

This effect can be understood through several theoretical lenses. First, mental accounting theory suggests that daily amounts are more readily integrated into routine expense mental budgets (Thaler, 1985). The substantially higher observed contributions with daily frames over weekly and monthly amounts, aligns with the "pennies-a-day" effect, where smaller, more frequent amounts feel more manageable within mental budgets (Gourville, 1998). Second, construal level theory (Trope & Liberman, 2010) provides an additional potential explanation: daily frames reduce psychological distance, making the saving behavior feel more concrete and actionable compared to the more abstract temporally distant weekly or monthly frames. Third, the preference for daily amounts may reflect the operation of present bias (O'Donoghue & Rabin, 2015; Xiao & Porto, 2019), where individuals find it easier to commit to smaller immediate actions rather than larger future ones, even when mathematically equivalent. Fourth, cognitive load theory (Sweller, 1988) suggests that

processing smaller daily amounts requires less mental effort than calculating and evaluating larger periodic sums, potentially facilitating more optimistic assessments of saving capacity.

Anchoring Effects on Monthly Savings

Regarding anchor conditions (social norm anchor, standard anchor, no anchor), contrary to our expectations, both social norm anchors and standard anchors resulted in significantly lower monthly saving amounts (€89.54 and €88.00 respectively) compared to the control condition (€104.76). This surprising finding challenges established anchoring literature and suggests that explicit anchor conditions might suppress saving intentions in this context (Schley, 2023; Tversky & Kahneman, 1974).

However, it is important to note that the operationalization of the social norm condition only communicated that many individuals with similar profiles engage in some saving (e.g., “like 78% of clients”), without specifying a normative amount to save. As such, participants may have interpreted the norm as simply validating the act of saving any amount, rather than guiding decisions toward higher contributions. This subtle framing difference might dilute the traditional anchoring effect observed when precise numeric anchors are provided.

Future research should investigate whether providing explicit norms on the amount saved (e.g., a specific recommended contribution) could yield better results, as well as explore how different framings of social norms influence saving behaviors. Such insights could help refine interventions aimed at promoting more substantial retirement savings.

We consider several (theoretical) explanations for this counter intuitive finding. First, reactance theory (Brehm, 1966) suggests that the explicit presentation of reference points (i.e. social anchors) may trigger psychological resistance, particularly given the private and personal nature of financial decisions. Young adults, our target demographic, typically exhibit heightened sensitivity to perceived manipulation attempts (Steinberg & Monahan, 2007),

which may have manifested in lower contributions as a form of autonomy assertion. Second, social comparison theory (Festinger, 1954) offers an alternative explanation: the social norm condition ("like 78% of clients") may have backfired due to skepticism about peer comparison authenticity or perceived social pressure, aligning with research showing diminished effectiveness of social norms when their credibility is questioned (Cialdini & Goldstein, 2004). Third, the anchoring effect may have operated differently in this context due to what we term an "anchoring-as-ceiling" effect. Rather than serving as a starting point for upward adjustment as traditional anchoring theory would suggest, the numerical anchor (€2.72/day, €19.04/week, €82.50/month) might have functionally operated as an upper limit, constraining participants' consideration of higher contribution amounts. This interpretation aligns with research on reference-dependent preferences (Koszegi & Rabin, 2006), suggesting that explicitly provided reference points (i.e. social anchors) can create psychological boundaries that limit rather than expand decision horizons. Additionally, the combination of a continuous scale with explicit anchors may have triggered more deliberative processing (Kahneman, 2011), potentially reducing the effectiveness of automatic anchoring mechanisms typically observed in simpler decision contexts.

Willingness to Save

A notable finding emerges in the dissociation between actual saving amounts and willingness to implement similar decisions in real life. While temporal reframing and reference points significantly influenced contribution amounts, neither intervention affected participants' self-reported likelihood of implementing such decisions in real-world contexts. This disconnect between immediate decision-making and anticipated future behavior provides important theoretical insights. The consistent willingness across conditions, despite varying behavioral outcomes, suggests that the choice architecture influenced behavior without altering underlying attitudes or perceived commitment to saving. This aligns with dual-

process theories of decision-making (Kahneman, 2011), indicating that our interventions likely operated through automatic processes while leaving deliberative evaluations of future intentions unchanged. This pattern might also reflect what Sunstein (2019) calls "decisional ambivalence", where individuals appear to be "happy either way", or genuinely indifferent about various choice outcomes, particularly for distant, abstract decisions like retirement savings.

This finding extends our understanding of behavioral interventions' scope: while choice architecture can effectively shape immediate decisions, it may not fundamentally alter how individuals view their future financial behavior. Such a distinction is particularly relevant for financial decision-making, where the gap between intended and actual behavior is well-documented (Shefrin & Thaler, 1988). The observed pattern suggests that while temporal reframing can successfully influence point-of-decision behavior, sustainable long-term changes might require additional interventions that target deeper attitudinal changes or bridge the intention-action gap (Conner & Norman, 2022; Krijnen et al., 2022).

Interaction Effects of Interventions

Our analysis revealed no significant interaction between temporal framing and reference points, indicating that these mechanisms operate independently rather than synergistically. The consistent suppressing effect of reference points across temporal frames, and the persistent benefits of daily framing regardless of reference point presence, suggests these interventions operate through distinct psychological mechanisms.

This independence aligns with dual-process theory (Kahneman, 2011): temporal reframing might primarily operate through affective, System 1 processes by making saving amounts feel more manageable, while reference points potentially trigger more deliberative, System 2 processes by prompting active comparison and evaluation. The lack of interaction between these processes suggests they engage different cognitive pathways, with temporal frames

affecting perceived affordability and mental accounting (Thaler, 1985), while reference points influence social comparison and autonomy considerations (Brehm, 1966; Festinger, 1954).

Moreover, temporal framing appears to influence how people process the immediate, practical aspects of saving (e.g., "Can I afford €2.72 per day?"), while reference points affect higher-level decision-making related to social and personal standards (e.g., "Should I follow others' behavior?"). These distinct cognitive focuses could explain why combining these interventions neither enhanced nor diminished their individual effects. Such findings contribute to our understanding of how different behavioral interventions can coexist without interference, even when their individual effects operate in opposite directions.

The Role of Continuous Measurement

Our study's innovative use of a continuous measurement scale, rather than binary choices, may provide crucial insights into these findings. Unlike traditional binary enrollment decisions (e.g., Hershfield et al., 2020), continuous scales engage more deliberative thinking (Kahneman, 2011). When participants can freely choose any amount within a range, they must actively consider and evaluate their capacity and willingness to save, promoting more thoughtful decision-making. This aligns with research showing that granular choice architectures can reduce decision inertia and promote more active engagement (Brown et al., 2013; Johnson et al., 2012).

The superiority of daily framing in this continuous context suggests that its effectiveness extends beyond simple participation decisions to actual contribution levels. When people can fine-tune their commitment, smaller temporal frames appear to enable more optimistic assessments of saving capacity, possibly by making the financial sacrifice feel more manageable and concrete (Trope & Liberman, 2010).

Future research should explore these mechanisms further by designing studies that integrate both continuous and binary measurement approaches within a single framework.

Such a comparative approach could provide deeper insights into how different decision structures influence not only retirement plan participation rates but also the magnitude of contributions. This dual perspective would help clarify the conditions under which each method is most effective in encouraging retirement savings.

Potential Design Artefacts

Our results reveal that participants naturally opted for contribution amounts averaging above the lower maximum limit of €990 annually but below the upper maximum limit of €1,350. Specifically, when annualized, the average contributions were €1,282.22 for the daily condition, €1,011.36 for the weekly condition, and €1,093.80 for the monthly condition. This clustering suggests that participants may perceive amounts within this tax-advantaged range as optimal, guided by both financial incentives and implicit or subconscious normative cues.

The Belgian legislative framework likely serves as an implicit anchor, subtly shaping participants' perceptions of reasonable contribution levels. Anchoring, as described by Tversky & Kahneman (1974), demonstrates how individuals rely on salient reference points when making decisions, even in hypothetical contexts. Additionally, this behavior aligns with theories of bounded rationality (Simon, 1955), where individuals simplify complex decisions by defaulting to familiar benchmarks. Prospect theory further suggests that participants may exhibit loss aversion, avoiding contributions above the incentivized thresholds due to perceived diminishing returns on tax benefits (Kahneman & Tversky, 1979).

This pattern may also reflect a preference for maximizing perceived benefits without exceeding thresholds that reduce tax advantages, reinforcing the interplay between regulatory constraints and decision-making heuristics. Future studies should explore how different framing interventions or changes to legislative limits could impact savings behavior, particularly among individuals at varying levels of financial literacy (Mitchell & Lusardi, 2011).

Implications for Theory, Practice and Policy

Our findings advance theoretical understanding of behavioral interventions in financial decision-making in several ways. First, we extend temporal reframing theory (Gourville, 1998; LeBoeuf, 2006) beyond binary enrollment decisions to continuous contribution amounts, demonstrating its robustness in more complex decision environments. The superior performance of daily frames challenges traditional dual-process assumptions about how temporal framing operates (Kahneman & Frederick, 2002), suggesting its effectiveness lies not just in reducing participation barriers, but in fundamentally altering how people evaluate their saving capacity through competing intuitive processes (De Neys, 2023; Van Dessel et al., 2022). Rather than simply exploiting System 1 biases that require System 2 correction, daily frames appear to strengthen goal-aligned intuitions about saving feasibility while simultaneously weakening competing intuitions about resource scarcity (De Neys, 2023). Even when participants make seemingly suboptimal choices in other frames, their decreased decision confidence compared to control conditions suggests an implicit sensitivity to the advantages of higher contribution amounts (Voudouri et al., 2024). Second, our findings regarding lacking effects of reference points question traditional anchoring theory (Tversky & Kahneman, 1974), revealing that explicit benchmarks might suppress rather than enhance financial commitments, particularly among young adults making private financial decisions (Beshears et al., 2015; Dur et al., 2021).

For financial practitioners and advisors, these results suggest concrete ways to enhance retirement saving among young adults, building on established behavioral science principles (Benartzi et al., 2017; Thaler & Benartzi, 2004). The substantial impact of daily framing, outperforming the weekly frame by approximately 26.8% and the monthly frame by 17.2%, highlights the power of temporal reframing to drive higher contributions. This significant relative increase underscores the importance of structuring retirement products in a way that

leverages smaller, more manageable temporal frames, consistent with research on choice architecture in financial decision-making (Beshears et al., 2009; Choukhmane, 2024).

However, practitioners should exercise caution with reference points and social comparisons, as these might inadvertently reduce saving intentions, reflecting recent findings about the context-dependency of social influence in financial decisions (Banerjee & Das, 2023; Raue et al., 2020). The independence of temporal framing effects from reference points also suggests that advisors don't have to worry about complex interaction effects when implementing these strategies, supporting earlier work on the robustness of temporal framing interventions (Gourville, 1998).

From a policy perspective, these findings hold important implications for addressing the retirement savings gap. Given that 54% of Belgian households fail to save consistently (Deloitte Belgium, 2023), the effectiveness of daily framing offers a low-cost, scalable intervention for boosting retirement contributions, aligning with research on cost-effective behavioral interventions (Benartzi et al., 2017; Hummel & Maedche, 2019). Policymakers might consider further investigating daily frame presentations alongside traditional monthly or annual figures in retirement communications, following successful precedents of behaviorally-informed policy interventions (Lusardi & Messy, 2023; Meier et al., 2017). However, policies requiring social norm or anchoring information should be carefully evaluated, as these might not yield the intended positive effects, consistent with emerging evidence on the limitations of social influence in financial contexts (Dur et al., 2021; Kuchler & Stroebe, 2021).

Conclusion

This study demonstrates how temporal framing influences retirement savings decisions among young adults, revealing daily contribution framing as an effective tool for enhancing saving commitments. The substantial compounding effects of increased

contributions, amounting to thousands of euros over time, highlight how subtle changes in decision presentation can potentially substantially impact long-term financial security.

However, our findings challenge conventional wisdom about behavioral interventions. The unexpected suppressing effect of providing reference points (i.e. (social) anchors), combined with the disconnect between immediate decisions and future intentions, suggests greater complexity in young adults' financial decision-making than previously theorized. In a socio-economic climate that increases individual retirement responsibility, the effectiveness of daily framing, without requiring social comparisons or anchors, offers an elegant approach to nudging younger generations toward better financial futures.

These insights provide a promising direction as societies face demographic shifts and pension system pressures, demonstrating how choice architecture aligned with psychological realities can enhance financial decision-making while preserving individual autonomy.

References

- Ariely, D., Loewenstein, G., & Prelec, D. (2003). "Coherent Arbitrariness": Stable Demand Curves Without Stable Preferences*. *The Quarterly Journal of Economics*, 118(1), 73-106. <https://doi.org/10.1162/00335530360535153>
- Asch, S. E. (1956). Studies of independence and conformity: I. A minority of one against a unanimous majority. *Psychological Monographs: General and Applied*, 70(9), 1-70. <https://doi.org/10.1037/h0093718>
- Bambauer-Sachse, S., & Grewal, D. (2011). Temporal Reframing of Prices: When Is It Beneficial? *Journal of Retailing*, 87(2), 156-165. <https://doi.org/10.1016/j.jretai.2011.02.002>
- Banerjee, P., & Das, T. (2023). *Peer Effects on Complex Financial Decisions* (SSRN Scholarly Paper No. 4557501). <https://doi.org/10.2139/ssrn.4557501>
- Bayar, Y. (2018). Financial Sustainability of Pension Systems in the European Union. *European Research Studies*, XVI(3), 46-70.
- Benartzi, S., Beshears, J., Milkman, K. L., Sunstein, C. R., Thaler, R. H., Shankar, M., Tucker-Ray, W., Congdon, W. J., & Galing, S. (2017). Should Governments Invest More in Nudging? *PSYCHOLOGICAL SCIENCE*, 28(8), 1041-1055. <https://doi.org/10.1177/0956797617702501>
- Benartzi, S., & Thaler, R. H. (2013). Behavioral Economics and the Retirement Savings Crisis. *SCIENCE*, 339(6124), 1152-1153. <https://doi.org/10.1126/science.1231320>
- Beshears, J., Choi, J. J., Laibson, D., & Madrian, B. C. (2009). The Importance of Default Options for Retirement Saving Outcomes: Evidence from the United States. *NBER Chapters*, 167-195.

- Beshears, J., Choi, J. J., Laibson, D., Madrian, B. C., & Milkman, K. L. (2015). The Effect of Providing Peer Information on Retirement Savings Decisions. *The Journal of Finance*, 70(3), 1161-1201. <https://doi.org/10.1111/jofi.12258>
- Bielecki, M., Brzoza-Brzezina, M., & Kolasa, M. (2020). Demographics and the natural interest rate in the euro area. *European Economic Review*, 129, 103535. <https://doi.org/10.1016/j.euroecorev.2020.103535>
- Brehm, J. W. (1966). *A theory of psychological reactance* (pp. x, 135). Academic Press.
- Brown, J. R., Ivković, Z., Smith, P. A., & Weisbenner, S. (2008). Neighbors Matter: Causal Community Effects and Stock Market Participation. *The Journal of Finance*, 63(3), 1509-1531. <https://doi.org/10.1111/j.1540-6261.2008.01364.x>
- Brown, J. R., Kling, J. R., Mullainathan, S., & Wrobel, M. V. (2013). *Framing Lifetime Income* (No. w19063). National Bureau of Economic Research. <https://doi.org/10.3386/w19063>
- Chapman, G. B., & Johnson, E. J. (1994). The limits of anchoring. *Journal of Behavioral Decision Making*, 7(4), 223-242. <https://doi.org/10.1002/bdm.3960070402>
- Choukhmane, T. (2024). *Default Options and Retirement Saving Dynamics*. <https://tahachoukhmane.com/wp-content/uploads/2024/04/Choukhmane-2024-Default-options.pdf>
- Cialdini, R. B., & Goldstein, N. J. (2004). Social influence: Compliance and conformity. *Annual Review of Psychology*, 55, 591-621. <https://doi.org/10.1146/annurev.psych.55.090902.142015>
- Cialdini, R. B., & Trost, M. R. (1998). Social influence: Social norms, conformity and compliance. In *The handbook of social psychology*, Vols. 1-2, 4th ed (pp. 151-192). McGraw-Hill.

- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed). L. Erlbaum Associates.
- Conner, M., & Norman, P. (2022). Understanding the intention-behavior gap: The role of intention strength. *Frontiers in Psychology, 13*.
<https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2022.923464>
- De Neys, W. (2023). Further advancing fast-and-slow theorizing. *Behavioral and Brain Sciences, 46*, e146. <https://doi.org/10.1017/S0140525X23000559>
- Deloitte Belgium. (2023). *Financial health in Belgium*.
<https://www.deloitte.com/be/en/Industries/financial-services/research/financial-health.html>
- Duflo, E., & Saez, E. (2002). Participation and investment decisions in a retirement plan: The influence of colleagues' choices. *Journal of Public Economics, 85*(1), 121-148.
- Duflo, E., & Saez, E. (2003). The Role of Information and Social Interactions in Retirement Plan Decisions: Evidence from a Randomized Experiment*. *The Quarterly Journal of Economics, 118*(3), 815-842. <https://doi.org/10.1162/00335530360698432>
- Dur, R., Fleming, D., van Garderen, M., & van Lent, M. (2021). A social norm nudge to save more: A field experiment at a retail bank. *Journal of Public Economics, 200*, 104443.
<https://doi.org/10.1016/j.jpubeco.2021.104443>
- EU commission. (2023). *The impact of demographic change in Europe* (Green Paper on Ageing No. SWD(2021) 282; p. 20). European Commission.
https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/new-push-european-democracy/impact-demographic-change-europe_en
- Eurostat. (2024, februari). Fertility statistics 2022. *Eurostat World Data Statistics Explained*.
https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Fertility_statistics
- Festinger, L. (1954). *A Theory of Social Comparison Processes*. 7(2), 117-140.

- Fraser, C., Hite, R. E., & Sauer, P. L. (1988). Increasing contributions in solicitation campaigns: The use of large and small anchorpoints. *Journal of Consumer Research*, 15(2), 284-287. <https://doi.org/10.1086/209166>
- Gourville, J. T. (1998). Pennies-a-Day: The Effect of Temporal Reframing on Transaction Evaluation. *Journal of Consumer Research*, 24(4), 395-408. <https://doi.org/10.1086/209517>
- Hershfield, H. E., Shu, S., & Benartzi, S. (2020). Temporal Reframing and Participation in a Savings Program: A Field Experiment. *Marketing Science*, 39(6), 1039-1051. <https://doi.org/10.1287/mksc.2019.1177>
- Hummel, D., & Maedche, A. (2019). How effective is nudging? A quantitative review on the effect sizes and limits of empirical nudging studies. *Journal of Behavioral and Experimental Economics*, 80, 47-58. <https://doi.org/10.1016/j.socec.2019.03.005>
- Jaber, M. (2010). Temporal reframing of prices: A conceptual framework. *LSU Doctoral Dissertations*. https://doi.org/10.31390/gradschool_dissertations.2217
- Johnson, E. J., Shu, S. B., Dellaert, B. G. C., Fox, C., Goldstein, D. G., Häubl, G., Larrick, R. P., Payne, J. W., Peters, E., Schkade, D., Wansink, B., & Weber, E. U. (2012). Beyond nudges: Tools of a choice architecture. *Marketing Letters*, 23(2), 487-504. <https://doi.org/10.1007/s11002-012-9186-1>
- Kahneman, D. (2011). *Thinking, fast and slow*. Farrar, Straus and Giroux.
- Kahneman, D., & Frederick, S. (2002). Representativeness Revisited: Attribute Substitution in Intuitive Judgment. In D. Griffin, D. Kahneman, & T. Gilovich (Red.), *Heuristics and Biases: The Psychology of Intuitive Judgment* (pp. 49-81). Cambridge University Press. <https://doi.org/10.1017/CBO9780511808098.004>
- Kahneman, D., & Tversky, A. (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica*, 47(2), 263-291. <https://doi.org/10.2307/1914185>

- Koszegi, B., & Rabin, M. (2006). A Model of Reference-Dependent Preferences. *The Quarterly Journal of Economics*, 121(4), 1133-1165.
- Krijnen, J. M. T., Zeelenberg, M., Breugelmans, S. M., & Schors, A. V. D. (2022). Intention and action in retirement preparation. *Behavioural Public Policy*, 6(2), 191-212.
<https://doi.org/10.1017/bpp.2018.39>
- Kubik, J. D., Hong, H. G., & Stein, J. C. (2001). *Social Interaction and Stock Market Participation* (SSRN Scholarly Paper No. 274077).
<https://doi.org/10.2139/ssrn.274077>
- Kuchler, T., & Stroebe, J. (2021). Social Finance. *Annual Review of Financial Economics*, 13(Volume 13, 2021), 37-55. <https://doi.org/10.1146/annurev-financial-101320-062446>
- Laibson, D. (1997). Golden Eggs and Hyperbolic Discounting. *The Quarterly Journal of Economics*, 112(2), 443-477.
- LeBoeuf, R. A. (2006). Discount rates for time versus dates: The sensitivity of discounting to time-interval description. *Journal of Marketing Research*, 43(1), 59-72.
<https://doi.org/10.1509/jmkr.43.1.59>
- Lee, R., & Mason, A. (2010). Some macroeconomic aspects of global population aging. *Demography*, 47(1), S151-S172. <https://doi.org/10.1353/dem.2010.0002>
- Lusardi, A., & Messy, F.-A. (2023). The importance of financial literacy and its impact on financial wellbeing. *Journal of Financial Literacy and Wellbeing*, 1(1), 1-11.
<https://doi.org/10.1017/flw.2023.8>
- Madrian, B. C., & Shea, D. F. (2001). The Power of Suggestion: Inertia in 401(k) Participation and Savings Behavior*. *The Quarterly Journal of Economics*, 116(4), 1149-1187. <https://doi.org/10.1162/003355301753265543>
- Markowitz, H. (1952). The Utility of Wealth. *Journal of Political Economy*, 60(2), 151-158.

- Mckenzie, C. R. M., & Liersch, M. J. (2011). Misunderstanding Savings Growth: Implications for Retirement Savings Behavior. *Journal of Marketing Research*, 48(SPL), S1-S13. <https://doi.org/10.1509/jmkr.48.SPL.S1>
- Meier, S., Madrian, B., Hershfield, H., Sussman, A., Bhargava, S., Burke, J., Huettel, S., Jamison, J., Johnson, E., Lynch, J., Rick, S., & Shu, S. (2017). Behaviorally Informed Policies for Household Financial Decisionmaking. *Behavioral Science & Policy*, 3, 27-40.
- Mitchell, O., & Lusardi, A. (2011). *Financial Literacy: Implications for Retirement Security and the Financial Marketplace* [OUP Catalogue]. Oxford University Press. <https://econpapers.repec.org/bookchap/oxpobooks/9780199696819.htm>
- Munnell, A. H., & Sass, S. A. (2008). *Working Longer: The Solution to the Retirement Income Challenge*. Brookings Institution Press. <https://www.jstor.org/stable/10.7864/j.ctt6wph6r>
- Munnell, A., Rutledge, M. S., & Webb, A. (2014). *Are Retirees Falling Short? Reconciling the Conflicting Evidence* (SSRN Scholarly Paper No. 2530024). Social Science Research Network. <https://doi.org/10.2139/ssrn.2530024>
- Nolan, J. M., Schultz, P. W., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2008). Normative Social Influence is Underdetected. *Personality and Social Psychology Bulletin*, 34(7), 913-923. <https://doi.org/10.1177/0146167208316691>
- O'Donoghue, T., & Rabin, M. (2015). Present Bias: Lessons Learned and to Be Learned. *American Economic Review*, 105(5), 273-279. <https://doi.org/10.1257/aer.p20151085>
- OECD. (2023). *Pensions at a Glance 2023*. <https://www.oecd-ilibrary.org/content/publication/678055dd-en>
- OECD. (2024). *How's Life? 2024: Well-being and Resilience in Times of Crisis*. OECD. <https://doi.org/10.1787/90ba854a-en>

- Oeppen, J., & Vaupel, J. W. (2002). Broken Limits to Life Expectancy. *Science*, 296(5570), 1029-1031. <https://doi.org/10.1126/science.1069675>
- Raue, M., D'Ambrosio, L. A., & Coughlin, J. F. (2020). The Power of Peers: Prompting Savings Behavior Through Social Comparison. *Journal of Behavioral Finance*, 21(1), 1-13. <https://doi.org/10.1080/15427560.2019.1587762>
- Riley, J. C. (2005). Estimates of Regional and Global Life Expectancy, 1800–2001. *Population and Development Review*, 31(3), 537-543. <https://doi.org/10.1111/j.1728-4457.2005.00083.x>
- Schley, D. (2023). *50 Years of Anchoring: A Meta-Analysis and Meta-Study of Anchoring Effects* (SSRN Scholarly Paper No. 4605057). Social Science Research Network. <https://doi.org/10.2139/ssrn.4605057>
- Shefrin, H. M., & Thaler, R. H. (1988). The Behavioral Life-Cycle Hypothesis. *Economic Inquiry*, 26(4), 609-643. <https://doi.org/10.1111/j.1465-7295.1988.tb01520.x>
- Shu, S., Hershfield, H., Mason, R., & Benartzi, S. (2022). *Reducing Savings Gaps Through Pennies Versus Percent Framing* (SSRN Scholarly Paper No. 4042843). Social Science Research Network. <https://doi.org/10.2139/ssrn.4042843>
- Simon, H. A. (1955). A Behavioral Model of Rational Choice. *The Quarterly Journal of Economics*, 69(1), 99-118. <https://doi.org/10.2307/1884852>
- Steinberg, L., & Monahan, K. C. (2007). Age differences in resistance to peer influence. *Developmental Psychology*, 43(6), 1531-1543. <https://doi.org/10.1037/0012-1649.43.6.1531>
- Sunstein, C. R. (2019). Chapter 4: Happy Either Way. In *Chapter 4: Happy Either Way* (pp. 81-112). Princeton University Press. <https://doi.org/10.1515/9780691192024-005>
- Sweller, J. (1988). Cognitive Load During Problem Solving: Effects on Learning. *Cognitive Science*, 12(2), 257-285. https://doi.org/10.1207/s15516709cog1202_4

- Thaler, R. (1985). Mental Accounting and Consumer Choice. *Marketing Science*, 4(3), 199-214.
- Thaler, R. H., & Benartzi, S. (2004). Save More TomorrowTM: Using Behavioral Economics to Increase Employee Saving. *Journal of Political Economy*, 112(S1), S164-S187.
<https://doi.org/10.1086/380085>
- Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decisions about health, wealth, and happiness* (pp. x, 293). Yale University Press.
- Trope, Y., & Liberman, N. (2010). Construal-level theory of psychological distance. *Psychological Review*, 117(2), 440-463. <https://doi.org/10.1037/a0018963>
- Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science*, 185(4157), 1124-1131. <https://doi.org/10.1126/science.185.4157.1124>
- Van Dessel, P., Boddez, Y., & Hughes, S. (2022). Nudging societally relevant behavior by promoting cognitive inferences. *Scientific Reports*, 12(1), Article 1.
<https://doi.org/10.1038/s41598-022-12964-1>
- Voudouri, A., Białek, M., & De Neys, W. (2024). Fast & slow decisions under risk: Intuition rather than deliberation drives advantageous choices. *Cognition*, 250, 105837.
<https://doi.org/10.1016/j.cognition.2024.105837>
- Xiao, J. J., & Porto, N. (2019). Present bias and financial behavior. *FINANCIAL PLANNING REVIEW*, 2(2), e1048. <https://doi.org/10.1002/cfp2.1048>

Supplementary Information

Table S1

Descriptives Non-Categorical Individual Characteristics

	<i>M</i>	<i>SD</i>	Min.	Max.	α	<i>items</i>
Financial Literacy	.6	.3	0.0	1.0	.60	3
Family Financial Socialization	3.5	1.0	1.0	5.0	.76	3
Self-Control	2.9	0.7	1.0	4.8	.67	6

Note. $N = 631$. Self-control was measured with the brief self-control scale (Tangney et al., 2004; e.g., “I do things that feel good in the moment, but that I will regret later on”) on a 5-point Likert scale. Financial literacy was assessed using the Lusardi and Mitchell (2011) questionnaire (e.g., “Suppose you had \$100 in a savings account and the interest rate was 2% per year. After 5 years, how much would you have?”). Family financial socialization was measured with items adapted from Vosylis and Erentaitė (2020); e.g., “My parents used to speak openly about their financial situation”) on a 5-point Likert scale.

Table S2*Frequencies Categorical Individual Characteristics*

	<i>n</i>	%
Highest Educational Degree		
Secondary Education	357	56.6
University College	97	15.4
University	177	28.1
Employment Status		
Student	21	1.5
Official	173	27.4
Laborer	22	3.5
Employee	39	6.2
Self-Employed	52	8.2
Other	19	3.0
Salary		
< 500	229	36.3
500 - 999	59	9.4
1000 - 1499	30	4.8
1500 - 1999	41	6.5
2000 - 2499	98	15.5
2500 - 3000	58	9.2
> 3000	62	9.8
No Answer	54	8.6

Note. *N* = 631.

4

Go With the Flow? Default Effects and Dynamic Norms in Occupational Pension Decisions

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Abstract

Despite the growing importance of occupational pensions in securing retirement income, participation rates in voluntary schemes remain largely suboptimal. This study investigates how behavioral choice architecture interventions, more specifically default nudges and dynamic peer norms, influence enrollment decisions in occupational pension plans. In a randomized vignette experiment with 1,361 Belgian employees, we examined the effectiveness of opt-out defaults and dynamic peer norms (DPN) intervention in a hypothetical occupational pension enrollment decision at the moment of hiring. Results demonstrate a significant main effect of defaults on enrollment likelihood (Cohen's $d=.21$), with opt-out conditions showing higher enrollment (72.6%) compared to opt-in conditions (64.1%), even when substantial procedural friction (scheduling an appointment) was required for both opting in and out. Contrary to expectations, DPN showed no significant effect, nor did this intervention interact with defaults. Age emerged as a significant predictor of enrollment, with older participants showing higher participation likelihood. These findings extend previous U.S.-based research to a European context, suggesting that default effects remain robust across different pension systems and procedural barriers. However, the ineffectiveness of dynamic norms indicates that social influence may operate differently in financial decisions within strong social security contexts. Our results have important implications for pension policy design, suggesting that while defaults are universally effective, dynamic norm interventions may require careful adaptation to cultural and institutional contexts.

Statement of Relevance

This study addresses a critical societal challenge: ensuring adequate retirement provisions in an aging Europe where pension responsibilities increasingly shift from institutions to individuals. By examining behavioral interventions in occupational pension enrollment, we provide actionable insights for policymakers and pension administrators. Our finding that default effects remain powerful even with high-effort barriers is particularly relevant for European pension systems, where administrative friction is often unavoidable. Moreover, our results challenge assumptions about the effectiveness of social norm interventions within the context of retirement decision making, suggesting that behavioral strategies successful in other domains may require adaptation within strong welfare state contexts. As European countries continue to reform their pension systems to ensure long-term sustainability, understanding how to effectively encourage supplementary pension participation becomes crucial. Our findings offer evidence-based guidance for designing choice architecture that can help bridge the growing pension gap while respecting individual autonomy.

Introduction

Rising life expectancy and decreasing fertility rates continue to significantly reshape global population composition (Miles, 2023). Today, one in five Europeans is aged 65 or older, with projections indicating this number will grow to almost 30% by 2050 (Grinin et al., 2023; OECD, 2023). This demographic shift has placed immense pressure on pension systems, as a larger share of the population spends more years in retirement while the shrinking workforce struggles to support them (OECD, 2023). Moreover, financial constraints and low interest rates are further adding to the issue, resulting in a decreasing ratio of retirement income relative to pre-retirement employment income (Bayar, 2018; Bielecki et al., 2020; OECD, 2019). As retirement planning responsibilities shift from institutions to individuals (Gad-Harf, 2008), concerns about the sustainability of pension systems across Europe are growing (Bayar, 2018; Lusardi & Messy, 2023). In this context, occupational pension schemes, which add a fiscally beneficial layer of financial security, play a crucial role in supporting an aging population. These occupational pensions are typically funded jointly by employers and employees, with contributions deducted directly from wages and often supplemented by employer matches. The funds are then invested to grow over time, ensuring a supplementary income for employees upon retirement. They complement the increasingly fragile state pensions and voluntary saving initiatives, forming a crucial buffer to prevent old-age income shortages (Barslund, 2020; Lessenich, 2007; OECD, 2023).

Recognizing the importance of occupational pensions to achieve financial stability in later stages of life, initiatives to increase enrollment have gained momentum. In the United States (U.S.), research by Thaler & Benartzi, (2004), along with others (e.g. Benartzi & Thaler, 2013; Beshears et al., 2009; J. Choi et al., 2004; J. J. Choi et al., 2001; Duflo & Saez, 2002; Eckert & McCoy, 2024; Madrian & Shea, 2000) has highlighted the effectiveness of behavioral interventions such as automatic enrollment and social influence in overcoming

decision inertia. Automatic enrollment refers to the practice of enrolling employees into pension plans by default, with the option to opt-out, which drastically increases participation compared to opt-in systems (Beshears et al., 2009; Thaler & Benartzi, 2004). Meanwhile, social influence leverages the behavior of peers and colleagues to encourage higher participation, as individuals are often motivated to align with group norms. These interventions have been successful in overcoming decision-making barriers and driving higher engagement in occupational pension schemes. However, despite the proven impact of these various behavioral influence strategies in the U.S., there remains a significant knowledge gap in optimizing occupational pension uptake within Europe (Castellino et al., 2020). The European context, with its diverse pension structures and regulatory frameworks, poses unique challenges that limit the direct applicability of these U.S.-based findings. This gap presents an opportunity to adapt and test behavioral strategies, like those pioneered by Thaler & Benartzi (2004), within European pension systems.

This study aims to bridge this gap by investigating how defaults and dynamic social norms can be leveraged to enhance participation in occupational pensions in a European context.

Structural Barriers to Pension Participation in Europe

While the U.S. has successfully implemented behavioral interventions like automatic enrollment to significantly boost occupational pension participation, with robust empirical support from numerous studies (e.g. Beshears et al., 2009; Choi et al., 2004; Madrian & Shea, 2001), substantial structural and cultural differences between the U.S. and Europe complicate direct comparisons or straightforward adaptations of these behavioral strategies to the European context (Castellino et al., 2020). In the U.S., the relatively weak social safety net and reliance on employer-sponsored, and privately managed, occupational retirement plans make the consequences of inadequate saving, such as poverty or lack of healthcare access,

highly visible (Lusardi & Mitchell, 2011; Munnell et al., 2014). In contrast, many European countries provide more robust social security systems, offering a foundational retirement income (OECD, 2023). This creates a perception among European citizens that state provisions will sufficiently support them in old age, reducing the urgency to engage with non-obligatory additional occupational pension schemes (Anderson, 2015). Consequently, European workers may exhibit lower awareness of the potential long-term consequences of failing to enroll in or adequately contribute to their occupational pensions.

Psychological Barriers to Pension Participation in Europe

This lack of urgency is further compounded by well-documented cognitive biases that shape financial decision-making (Berthet, 2022; Jain et al., 2023; Kahneman & Tversky, 1979; Laibson, 1997; Moya-Ponce & Madrazo-Lemaroy, 2023). One prominent bias is loss aversion, where individuals weigh potential losses more heavily than equivalent gains (Kahneman & Tversky, 1979). In the context of pensions, this may manifest as a reluctance to reduce current disposable income by contributing to a retirement plan, as the perceived loss of current earnings outweighs the future benefits of retirement savings (Hwang, 2024; Lim et al., 2019; Xie et al., 2017). Additionally, present bias, or the tendency to prioritize immediate rewards over future ones, leads to procrastination in retirement planning, as the distant prospect of retirement seems less pressing than immediate financial needs (Laibson, 1997; O'Donoghue & Rabin, 2015).

Furthermore, status quo bias refers to individuals' preference for maintaining existing conditions, even when making a change might yield better outcomes (Samuelson & Zeckhauser, 1988). Indeed, the presence of strong social safety nets in Europe may exacerbate the human tendency to follow the path of least resistance and engage less with additional savings options, because they are accustomed to external (governmental) social security management (Anderson, 2015; Barr & Diamond, 2009). Research by Madrian & Shea, (2001)

showed that even when minimal effort is required to improve financial outcomes, many still fail to act. Another critical barrier to effective retirement planning stems from the social isolation in which many retirement decisions are made. Although humans are inherently social creatures who often rely on contextual and social cues to guide their behavior, also known as conformity bias (Asch, 1956). Conformity bias becomes more pronounced in complex or uncertain situations such as retirement planning, where the brain's natural tendency is to seek patterns and simplify complex information (P. Banerjee & Das, 2023; Cialdini & Trost, 1998; Nolan et al., 2008). Pension decisions are frequently made in private, with little insight into the actions of peers, neighbors, or colleagues (P. Banerjee & Das, 2023; Benartzi & Thaler, 2013). The absence of social reference points in retirement decisions can result in under-saving or deferring contributions, as individuals lack the opportunity to observe or be influenced by others' behaviors (Duflo & Saez, 2003a; Dur et al., 2021).

Nudging Pension Participation

To overcome these various psychological barriers to occupational pension participation, behavioral scientists often employ interventions in decision-making environments known as 'nudges' (Thaler & Sunstein, 2008). These nudges are designed to subtly guide individuals toward more beneficial choices without restricting their freedom of choice or significantly altering economic incentives. Nudges are rooted in dual process theory, which metaphorically describes decision-making as driven by two distinct cognitive processes: System 1 and System 2 (Evans, 2008). System 1 is fast, intuitive, and automatic, while System 2 is slower, more analytical, and requires conscious effort (Kahneman, 2011). Individuals often default to System 1 for its efficiency, especially in complex tasks like future financial planning (Evans, 2008; Robalino et al., 2023). Traditionally, this reliance on quick, heuristic-based thinking was thought to inevitably result in decisions misaligned with long-term interests, like under-saving for retirement (Ladrón de Guevara Cortés et al., 2023).

However, recent theoretical developments challenge this strict dichotomy and the assumption that System 1 processing inherently leads to suboptimal choices (De Neys, 2023). Evidence suggests that intuitive processing can generate multiple competing responses simultaneously, both heuristic-based and logic-based, with their relative strength determining the chosen action (Bago & De Neys, 2019; Voudouri et al., 2024). Even when making seemingly biased choices, people often show decreased confidence compared to control situations, suggesting an implicit sensitivity to logical principles within intuitive processing (De Neys, 2023). This revised theoretical understanding suggests that behavioral nudges may work not by merely exploiting System 1 biases or forcing System 2 engagement, but rather by influencing the relative strength of competing intuitions and facilitating productive inferential processes (Van Dessel et al., 2022). In financial decision-making contexts, effective nudges might therefore succeed by strengthening goal-aligned intuitions through contextual cues that highlight both immediate feasibility and long-term benefits.

Defaults

One of the most effective nudges in promoting pension participation is the use of defaults. Defaults are pre-set options that dictate the outcome when no active choice is made, leveraging status quo bias (Samuelson & Zeckhauser, 1988). In pensions, defaults typically take the form of automatic enrollment, where individuals are enrolled by default but can opt-out. This simple shift from an opt-in to an opt-out structure increases participation rates drastically. The success of defaults lies in their ability to harness status quo bias and individuals' preference for the path of least resistance, aligning with System 1's inclination for automatic, intuitive decisions while still allowing individuals the freedom to make an active choice if they engage System 2. At the same time, they override present bias by simplifying the otherwise deferred decision to save for the future, allowing individuals to bypass the need for active deliberation (Laibson, 1997). Defaults may also derive part of their effectiveness

from subtle effort costs, such as cognitive load or time, that discourage deviations, also known as ‘friction’. While defaults reduce friction for the pre-set option, they increase it for alternatives, making active decisions more demanding. This dynamic amplifies individuals’ tendency to stick with the easier choice, highlighting the behavioral mechanisms underpinning defaults (Carroll et al., 2009; van den Akker & Sunstein, 2023).

Meta-analytic evidence consistently demonstrates the power of defaults in increasing pension savings. A meta-analysis by Jachimowicz et al. (2019) including 58 studies and over 73,000 participants, found that default interventions produce a significant behavioral shift, with an average effect size of $d = 0.68$. In the domain of retirement planning, Madrian & Shea (2001) identified the profound effect of automatic enrollment in 401(k) plans in the U.S. : participation rates exceeded 90% among those automatically enrolled, compared to less than 50% under traditional opt-in schemes. Thaler & Benartzi (2004) built on these findings with their "Save More Tomorrow" program, which combined automatic enrollment with gradual automatic contribution increases, leading to a fourfold increase in savings rates among participating employees. These findings are echoed in studies from other countries, such as the UK’s introduction of automatic enrollment in 2012, which resulted in a marked increase in the number of workers contributing to workplace pensions (Cribb & Emmerson, 2020; Emmerson & Cribb, 2019). While the UK pension system may not be fully representative of the EU context, this evidence underscores the potential effectiveness of such interventions and highlights the need for further studies to evaluate their applicability across diverse European pension systems.

(Dynamic) Normative Influence

Although financial decisions are often made in isolation, humans are inherently social beings. Festinger's (1954) social comparison theory suggests that individuals evaluate their behaviors by comparing themselves to others. Empirical evidence consistently highlights the

role of social influences in financial decisions. For instance, Duflo & Saez (2002, 2003) showed that peer behaviors significantly impact retirement savings, while Kubik et al. (2001) and Brown et al. (2008) observed similar effects in stock market participation. Meta-analytical evidence by Hummel & Maedche (2019) further demonstrated that social nudges produce notable changes in behavior, with a median effect size indicating a 20% relative increase in the targeted behavior and an average effect size reflecting a 29% increase.

A noteworthy emerging line of research within the field of normative social influence investigates how conveying information about recent collective changes or trends in peer group behaviors over time, affects individual decision-making (Cialdini & Jacobson, 2021; Mortensen et al., 2019). For example, a dynamic norm might emphasize that an increasing number of people are getting vaccinated against the flu, whereas a static norm would merely state that a set percentage of people is currently vaccinated. A growing body of empirical evidence shows that these so-called ‘dynamic’ or ‘trending’ norms are often more effective at eliciting behavioral change when compared to static social norms, which highlight a current prevalence of behavior within a relevant peer group (Cheng et al., 2022; Geber et al., 2022; Lee & Liu, 2023; Sparkman & Walton, 2019).

Cialdini & Jacobson (2021) suggest that this trend-sensitivity reflects an ‘adaptive’ conformity bias. By signaling not just prevalence but momentum, dynamic norms cue System 1 to interpret these behaviors as a “safe” and future-oriented choice, lowering resistance to change while suppressing the need for System 2’s analytical involvement (Kahneman, 2011; Mortensen et al., 2019).

To date however, the empirical literature on dynamic normative influence, especially within an economic decision-making context remains scarce, indicating a promising opportunity for further study (Braams et al., 2019; Cialdini & Jacobson, 2021).

Age and Sex Effects in Behavioral Interventions

Research on the effectiveness of behavioral interventions, such as nudges, increasingly highlights the importance of individual differences across demographic groups. Specifically, age and sex appear to be critical interacting variables influencing how people respond to these interventions (de Ridder et al., 2022; Ingendahl et al., 2021; Wagler & Wells, 2024). Age differences, for example, may be linked to cognitive capacity, risk perception, and temporal preferences—factors that play a significant role in decision-making within contexts like pension planning (Delaney et al., 2021). Sex, on the other hand, may shape behavior through social norms and expectations. Differences in risk tolerance and financial preferences are notable, with women generally being more risk-averse (Charness & Gneezy, 2012; Croson & Gneezy, 2009).

In the context of nudges, such as defaults and dynamic peer norms (DPN), these demographic effects are particularly relevant. Previous studies have suggested, for instance, that men and women differ in their sensitivity to social norms, while different age groups may vary in their responsiveness to default options or adjustable interventions (S. Banerjee & John, 2022; Hummel & Maedche, 2019). These potential interaction effects underscore the need to integrate age and sex dimensions into research on nudging to develop a more comprehensive understanding of how behavioral interventions can be tailored to diverse populations.

Current Study

Strong state support in Europe may reduce perceived retirement risk, leading workers to overlook the long-term impact of not participating in these plans. The present study investigates the effects of opt-out default nudges and dynamic peer norms (DPN) on enrollment decisions within European occupational pensions, through a vignette study. While defaults and dynamic influence have proven effective in other contexts, their impact in a

European pension setting remains underexplored (OECD, 2023). Accordingly, we address three primary research questions:

RQ1: What are the main effects of opt-out default nudges and a dynamic peer norms (DPN) nudge on enrolment decision, when controlled for age and sex?

RQ2: To what extent do opt-out default nudges and a dynamic peer norms (DPN) nudges interact to influence enrolment decision, when controlled for age and sex?

RQ3: What are the main effects of age and sex on DPN nudges, across opt-out default nudges and DPN interventions?

Method

Participants

The sample comprised 1,361 employees from mid-sized private companies across Dutch-speaking Belgium, recruited through cold-outreach via their employer. Participants (63% male; $M_{age} = 35$, $SD = 11$, range [18-65]) predominantly held higher education degrees, with 41% university graduates and 35.1% university college graduates. See Table S1 and S2 of the supplementary information for complete participant demographics and individual characteristics. Monthly net income was fairly distributed across salary brackets between €1,750 and €3,500 (81.2% of sample). This study received formal approval from the university ethics board, with reference code 2021/138 FWO project nr.: S006721N. All participants provided informed consent prior to participation, in accordance with institutional and APA ethical guidelines. Participation in the study was entirely voluntary, and no rewards or incentives were offered to participants.

Design and Procedure

The study employed a 2 (Default: Opt-in vs. Opt-out) $\times$ 2 (DPN: Present vs. Absent) between-subjects experimental design investigating the effectiveness of nudging strategies on pension plan enrollment. Participants ($N = 1,361$) were recruited from mid-sized private

companies across Dutch-speaking Belgium. These companies were contacted directly, and the questionnaire was distributed to their employees via the intranet or through direct email.

Participants were randomly assigned to one of four conditions: baseline/opt-in ($n = 349$), opt-out ($n = 334$), opt-in + DPN ($n = 326$), or opt-out + DPN ($n = 352$).

Participants were presented with a hypothetical employment scenario where, prior to their first workday, they received an email from their prospective employer regarding their remuneration package. The email introduced an optional occupational pension plan requiring a 2% monthly contribution from their gross salary. A key feature of the plan specified that 15% of any future salary increases (through raises or indexation) would automatically be allocated to the pension fund, with the benefit of favorable tax treatment.

The experimental manipulations varied as follows: In the baseline (opt-in) condition, participants needed to actively schedule an appointment with the financial department to enroll. In the opt-out condition, participants were automatically enrolled but could withdraw by scheduling an appointment. The DPN conditions, presented in combination with either opt-in or opt-out, additionally included historical participation rates showing increasing adoption (19% in 2018, 47% in 2019, and over 84% of all employees in 2020).

After reading their assigned scenario, participants made their binary enrollment decision (participate/not participate through (not) making an appointment) and completed a questionnaire assessing demographic characteristics. The entire procedure was conducted online via Qualtrics, with participation requiring approximately five minutes.

Analyses

To examine the effects of opt-out default nudges and DPN nudges on enrollment decisions, we employed a 2x2 factorial design, comparing ‘opt-in’ versus ‘opt-out’ defaults and ‘DPN nudge versus ‘no DPN nudge’ conditions. This setup allowed us to analyze both

the main effects of the opt-out default and DPN nudges, as well as their interaction, on the likelihood of enrollment.

A binary logistic regression analysis was conducted with enrollment decision as the categorical dependent variable and the opt-out default nudge, DPN nudge, age, and sex as independent variables. The model included both the main effects of each predictor and the interaction effects between the opt-out default and DPN nudges, between age and sex. To evaluate the added predictive value of the interaction, we compared this model with one excluding the interaction term using a chi-square difference test.

Results were reported for the main effects of opt-out default nudges, DPN nudges, age, and sex based on Wald tests, using the model with the best fit. For significant effects, we also examined the exponentiated regression coefficients to interpret the odds ratios associated with each predictor.

Results

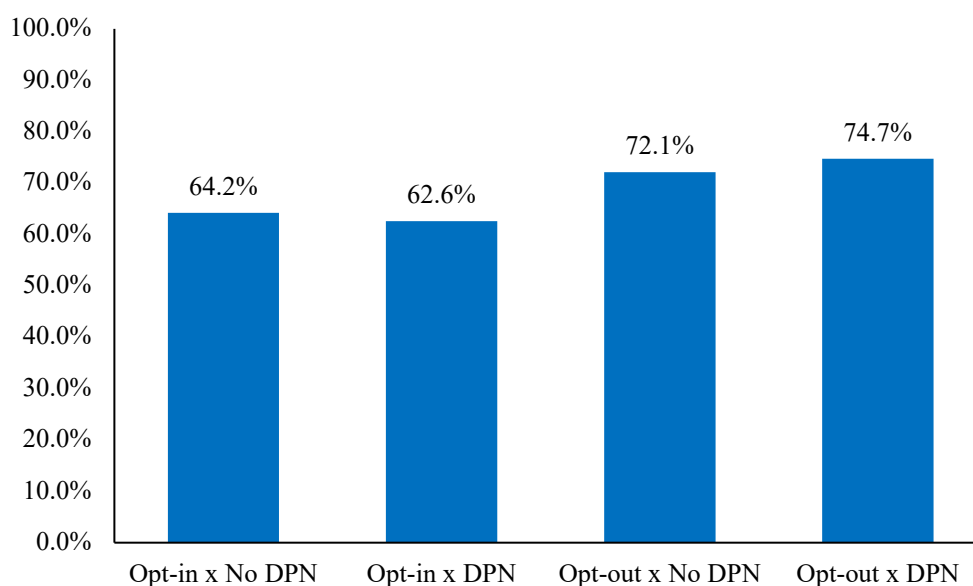
For RQ1, we investigated the main effects of a default nudge intervention and a DPN intervention on enrolment decision in an occupational pension plan, when controlling for age and sex. A binary logistic regression model, including the interaction between the DPN nudge and the default nudge on enrolment decision, shows a less optimal fit than the model excluding this interaction ($\chi^2(1, N = 1,361) = 0.72, p = .396$). Additionally, based on the model without the interaction between the DPN nudge and default nudge interventions on enrolment decision, we find a significant main effect of the default nudge intervention on enrolment decision ($Wald(1) = 10.09, p = .001$). The likelihood of enrolment in the occupational pension plan versus non-enrolment is higher (8.5%) for participants in the opt-out default condition than for participants in the opt-in default condition, with a factor $Exp(B) = 1.455$. The main effect of DPN interventions on enrolment decision is non-significant ($Wald(1) = 0.69, p = .407$).

For RQ2, we examined to what extent opt-out default nudges and dynamic peer norms (DPN) nudges interact to influence enrolment decision, when controlled for age and sex. The binary logistic regression model including the interaction between the DPN nudge and the default nudge interventions on enrolment decision, with a suboptimal model fit, confirms a non-significant interaction effect between the DPN intervention and the default nudge interventions on enrolment decision ($Wald(1) = 0.72, p = .396$). Figure 1 illustrates the observed percentage of enrolment decisions across the four experimental conditions.

For RQ3, we investigated the main effects of age and sex on enrolment decision, across opt-out default nudges and DPN nudges. The model without the interaction between the DPN intervention and default nudge interventions on enrolment decision shows a significant main effect of age on enrolment decision ($Wald(1) = 7.89, p = .005$). For every additional year, the likelihood of enrolment in the occupational pension plan versus non-enrolment increases, with a factor $Exp(B) = 1.017$. The main effect of sex on enrolment decision is non-significant ($Wald(1) = 2.00, p = .158$).

Figure 1

Enrolment Rates Across Default and DPN Nudge Conditions



Note. DPN= Dynamic Peer Norms.

Discussion

This vignette study investigated the effectiveness of default nudges and dynamic peer norms (DPN) in promoting occupational pension plan enrollment within a European context. Our findings demonstrate that default nudges influence enrollment decisions, while challenging previous assumptions about the universal effectiveness of social norm interventions in retirement planning.

Our study found a significant main effect of the default nudge on enrollment, with an 8.5% difference in enrollment rates between the opt-in and opt-out conditions, corresponding to a Cohen's $d = .21$. While effective, this result is substantially smaller than the average effect size ($d = 0.68$) reported in the default nudge meta-analysis by Jachimowicz et al. (2019) and the dramatic increases identified in seminal U.S.-based studies, such as Madrian & Shea (2001) where participation rates exceeded 90% under automatic enrollment compared to less than 50% in opt-in schemes. These differences may partly reflect cross-cultural variations in risk preferences and uncertainty avoidance, with European populations typically displaying greater risk aversion than their U.S. counterparts (Hsee & Weber, 1999; Rieger et al., 2015). Such cultural differences in risk attitudes could make European participants more hesitant to commit to long-term financial decisions even when presented as defaults. Additionally, recent theoretical developments suggest that defaults work not by merely exploiting System 1's tendency to accept the status quo, but through an interplay of competing intuitions about maintaining versus changing the current state (De Neys, 2023). The relatively modest effect size we observed may indicate that our procedural friction strengthened intuitions favoring active choice, partially counteracting the default's usual reinforcement of status quo intuitions.

Although procedural friction, like requiring participants to schedule an appointment to opt-in or opt-out, can sometimes amplify default effects by increasing the cognitive demand of active decisions (Carroll et al., 2009; van den Akker & Sunstein, 2023), our findings

suggest that this friction may have tempered the default effect in this context. Unlike fully automatic defaults, where the path of least resistance requires no action, the requirement to schedule an appointment likely prompted greater deliberation, reducing reliance on the pre-selected option (Hertwig & Grüne-Yanoff, 2017; Thaler, 2018). This aligns with contemporary dual process frameworks suggesting that increased procedural complexity can trigger conflict detection mechanisms that signal the need for more careful consideration of options (De Neys, 2023; Voudouri et al., 2024). In such cases, people may show heightened sensitivity to the trade-offs involved, even at an intuitive level, leading to more balanced consideration of both default and alternative options rather than simple acceptance of the pre-selected choice (Van Dessel et al., 2022) (Van Dessel et al., 2022).

Another potential contributing factor to this observed effect is the higher auto-escalation rate of 15% of future salary increases, which was used in our intervention compared to the 3% annual increase used in U.S. based studies (Thaler & Benartzi, 2004). This higher rate may have heightened participants' perceptions of loss aversion, discouraging enrollment even in the opt-out condition (Kahneman & Tversky, 1979). Combined with the procedural effort required, these elements likely interacted to reduce the strength of the default nudge's impact.

It's worth noting that our observed effect size is particularly modest given that we used a hypothetical vignette design. Prior research indicates that hypothetical scenarios typically produce larger effect sizes compared to real-world interventions, as participants in vignette studies often report more socially desirable or optimistic intentions when not facing actual financial or emotional consequences of their decisions (Ajzen et al., 2004; Hainmueller et al., 2015). This suggests that the modest default effect we observed might represent an upper bound, and real-world implementation could yield even smaller effects in this context. This

interpretation further emphasizes the importance of considering institutional context when applying behavioral interventions.

Another factor to consider is the cultural and institutional context in which defaults are applied. European countries, including the setting of our study, often have more robust social safety nets than the U.S., potentially reducing the perceived urgency of supplementary savings. In systems where state pensions are seen as a reliable foundation for retirement income, individuals may feel less compelled to actively engage with additional savings options, thereby diminishing the relative impact of defaults. This contrasts with U.S.-based studies, where weaker public retirement provisions place greater responsibility on individuals, likely amplifying the behavioral effects of automatic enrollment (Barr & Diamond, 2009; Castellino et al., 2020). These cultural differences underscore the importance of tailoring behavioral interventions to align with the perceived needs and expectations of individuals within specific institutional frameworks. Despite these contextual challenges, our findings reaffirm that automatic enrollment can serve as a powerful tool to overcome behavioral biases even in environments with stronger baseline support systems.

Contrary to expectations, we found no significant main effect of DPN interventions ($p = .407$), nor an interaction effect between DPN and default nudges ($p = .396$). This unexpected finding suggests that trending norms may operate differently in pension decisions compared to other behavioral domains where their effectiveness has been established (Mortensen et al., 2019; Sparkman & Walton, 2019). Several factors might explain this result. First, the private nature of financial decisions may reduce the salience or relevance of social comparisons, a phenomenon documented in previous research on financial decision-making (Beshears et al., 2015; Bicchieri et al., 2022). Second, the robust social security systems in Europe might dampen the perceived urgency of following peers' retirement saving behaviors (Barr & Diamond, 2009; OECD, 2023). This aligns with research showing that strong welfare

systems can reduce individual financial planning motivation (Anderson, 2015; Castellino et al., 2020).

Notably, age emerged as a significant predictor of enrollment ($\text{Exp}(B) = 1.017, p = .005$), with older participants showing higher likelihood of participation. This finding aligns with life-cycle theories of saving behavior (Modigliani, 1986) and recent empirical evidence on age-related differences in retirement planning (Clark et al., 2012; Lusardi & Messy, 2023). The age effect is consistent with temporal construal theory (Trope & Liberman, 2010), and availability heuristic (Tversky & Kahneman, 1973), suggesting that retirement becomes more psychologically proximate and concrete as people age. As a result, the urgency to engage in pension saving or work toward financial security increases, aligning with the shift from abstract, future-oriented thinking to more immediate, actionable concerns.

Our findings have important implications for policy makers and pension administrators. While default nudges appear robust across cultural contexts, dynamic peer norm interventions may require careful adaptation for financial decision-making, particularly in systems with strong social safety nets (Cronqvist et al., 2018; Sunstein & Reisch, 2019). The age effect suggests that younger workers might benefit from targeted interventions to overcome present bias in retirement planning (Goda et al., 2020; O'Donoghue & Rabin, 2015).

Future research should explore how different framing of dynamic norms might enhance their effectiveness in pension decisions, particularly for younger participants (Johnson et al., 2012; Luukkanen & Uusitalo, 2019). Additionally, investigating the long-term stability of default-driven enrollment decisions could provide valuable insights for policy design (Carroll et al., 2009; DellaVigna & Malmendier, 2006).

Conclusion

This study highlights the effectiveness of default nudges in increasing enrollment in European occupational pension schemes, even amid procedural barriers. Despite structural differences from U.S. systems, default effects remain robust, affirming their broad applicability. However, the ineffectiveness of dynamic peer norms suggests limits to social influence interventions in financially secure contexts.

Significant age effects underline the need for tailored approaches, as younger employees may require strategies to counter present bias. Yet, the consistent efficacy of default nudges across age groups suggests their universal relevance. Complementary strategies will be vital to address Europe's aging population and reliance on supplementary pensions.

Policy-wise, while automatic enrollment is broadly applicable, other interventions must consider cultural and contextual factors. As pension systems evolve, refining behavioral interventions will be essential to securing adequate retirement savings for future generations.

References

- Ajzen, I., Brown, T. C., & Carvajal, F. (2004). Explaining the Discrepancy between Intentions and Actions: The Case of Hypothetical Bias in Contingent Valuation. *Personality and Social Psychology Bulletin*, 30(9), 1108–1121.
<https://doi.org/10.1177/0146167204264079>
- Anderson, K. (2015). Pension Reform in Europe: Context, Drivers, Impact. In S. Scherger (Ed.), *Paid Work Beyond Pension Age: Comparative Perspectives* (pp. 177–197). Palgrave Macmillan UK. https://doi.org/10.1057/9781137435149_8
- Asch, S. E. (1956). Studies of independence and conformity: I. A minority of one against a unanimous majority. *Psychological Monographs: General and Applied*, 70(9), 1–70.
<https://doi.org/10.1037/h0093718>
- Bago, B., & De Neys, W. (2019). The intuitive greater good: Testing the corrective dual process model of moral cognition. *Journal of Experimental Psychology: General*, 148(10), 1782–1801. <https://doi.org/10.1037/xge0000533>
- Banerjee, P., & Das, T. (2023). *Peer Effects on Complex Financial Decisions* (SSRN Scholarly Paper No. 4557501). <https://doi.org/10.2139/ssrn.4557501>
- Banerjee, S., & John, P. (2022). *Nudge and Nudging in Public Policy* (SSRN Scholarly Paper No. 4314881). <https://doi.org/10.2139/ssrn.4314881>
- Barr, N., & Diamond, P. (2009). Reforming pensions: Principles, analytical errors and policy directions. *International Social Security Review*, 62(2), 5–29.
<https://doi.org/10.1111/j.1468-246X.2009.01327.x>
- Barslund, M. (2020). *Pension Systems in the EU – Some Policy Issues*. 2020(2), 69–72.
- Bayar, Y. (2018). Financial Sustainability of Pension Systems in the European Union. *European Research Studies*, XVI(3), 46–70.

- Benartzi, S., & Thaler, R. H. (2013). Behavioral Economics and the Retirement Savings Crisis. *SCIENCE*, 339(6124), 1152–1153. <https://doi.org/10.1126/science.1231320>
- Berthet, V. (2022). The Impact of Cognitive Biases on Professionals' Decision-Making: A Review of Four Occupational Areas. *Frontiers in Psychology*, 12. <https://doi.org/10.3389/fpsyg.2021.802439>
- Beshears, J., Choi, J. J., Laibson, D., & Madrian, B. C. (2009). The Importance of Default Options for Retirement Saving Outcomes: Evidence from the United States. *NBER Chapters*, 167–195.
- Beshears, J., Choi, J. J., Laibson, D., Madrian, B. C., & Milkman, K. L. (2015). The Effect of Providing Peer Information on Retirement Savings Decisions. *The Journal of Finance*, 70(3), 1161–1201. <https://doi.org/10.1111/jofi.12258>
- Bicchieri, C., Dimant, E., Gächter, S., & Nosenzo, D. (2022). Social proximity and the erosion of norm compliance. *Games and Economic Behavior*, 132, 59–72. <https://doi.org/10.1016/j.geb.2021.11.012>
- Bielecki, M., Brzoza-Brzezina, M., & Kolasa, M. (2020). Demographics and the natural interest rate in the euro area. *European Economic Review*, 129, 103535. <https://doi.org/10.1016/j.euroecorev.2020.103535>
- Braams, B. R., Davidow, J. Y., & Somerville, L. H. (2019). Developmental patterns of change in the influence of safe and risky peer choices on risky decision-making. *Developmental Science*, 22(1), e12717. <https://doi.org/10.1111/desc.12717>
- Brown, J. R., Ivković, Z., Smith, P. A., & Weisbenner, S. (2008). Neighbors Matter: Causal Community Effects and Stock Market Participation. *The Journal of Finance*, 63(3), 1509–1531. <https://doi.org/10.1111/j.1540-6261.2008.01364.x>

- Carroll, G. D., Choi, J. J., Laibson, D., Madrian, B. C., & Metrick, A. (2009). Optimal Defaults and Active Decisions*. *The Quarterly Journal of Economics*, 124(4), 1639–1674. <https://doi.org/10.1162/qjec.2009.124.4.1639>
- Castellino, O., Fornero, E., & Wilke, C. B. (2020). *Pension Policy in Europe and the United States – Towards a New Public-Private Pension Mix* (SSRN Scholarly Paper No. 3565087). Social Science Research Network. <https://doi.org/10.2139/ssrn.3565087>
- Charness, G., & Gneezy, U. (2012). Strong evidence for gender differences in risk taking. *Journal of Economic Behavior & Organization*, 83(1), 50–58. <https://doi.org/10.1016/j.jebo.2011.06.007>
- Cheng, L., Hao, M., Xiao, L., & Wang, F. (2022). Join us: Dynamic norms encourage women to pursue STEM. *Current Psychology*, 41(9), 5967–5977. <https://doi.org/10.1007/s12144-020-01105-4>
- Choi, J. J., Laibson, D., Madrian, B. C., & Metrick, A. (2001). *For Better or for Worse: Default Effects and 401(K) Savings Behavior* (SSRN Scholarly Paper No. 294089). Social Science Research Network. <https://papers.ssrn.com/abstract=294089>
- Choi, J., Laibson, D., Madrian, B., Metrick, A., & Wise, D. A. (2004). *Perspectives in the Economics of Aging* (pp. 81–121). University of Chicago Press.
- Cialdini, R. B., & Jacobson, R. P. (2021). Influences of social norms on climate change-related behaviors. *Current Opinion in Behavioral Sciences*, 42, 1–8. <https://doi.org/10.1016/j.cobeha.2021.01.005>
- Cialdini, R. B., & Trost, M. R. (1998). Social influence: Social norms, conformity and compliance. In *The handbook of social psychology, Vols. 1-2, 4th ed* (pp. 151–192). McGraw-Hill.

- Clark, G. L., Strauss, K., & Knox-Hayes, J. (2012). *Saving for Retirement: Intention, Context, and Behavior*. Oxford University Press.
- <https://doi.org/10.1093/acprof:oso/9780199600854.001.0001>
- Cribb, J., & Emmerson, C. (2020). What happens to workplace pension saving when employers are obliged to enrol employees automatically? *International Tax and Public Finance*, 27(3), 664–693. <https://doi.org/10.1007/s10797-019-09565-6>
- Cronqvist, H., Thaler, R. H., & Yu, F. (2018). When Nudges Are Forever: Inertia in the Swedish Premium Pension Plan. *AEA Papers and Proceedings*, 108, 153–158.
- <https://doi.org/10.1257/pandp.20181096>
- Croson, R., & Gneezy, U. (2009). Gender Differences in Preferences. *Journal of Economic Literature*, 47(2), 448–474. <https://doi.org/10.1257/jel.47.2.448>
- De Neys, W. (2023). Further advancing fast-and-slow theorizing. *Behavioral and Brain Sciences*, 46, e146. <https://doi.org/10.1017/S0140525X23000559>
- de Ridder, D., Kroese, F., & van Gestel, L. (2022). Nudgeability: Mapping Conditions of Susceptibility to Nudge Influence. *Perspectives on Psychological Science*, 17(2), 346–359. <https://doi.org/10.1177/1745691621995183>
- Delaney, R. K., Strough, J., Shook, N. J., Ford, C. G., & Lemaster, P. (2021). Don't Risk It. Older Adults Perceive Fewer Future Opportunities and Avoid Social Risk Taking. *The International Journal of Aging and Human Development*, 92(2), 139–157.
- <https://doi.org/10.1177/0091415019900564>
- DellaVigna, S., & Malmendier, U. (2006). Paying Not to Go to the Gym. *American Economic Review*, 96(3), 694–719. <https://doi.org/10.1257/aer.96.3.694>
- Duflo, E., & Saez, E. (2002). Participation and investment decisions in a retirement plan: The influence of colleagues' choices. *Journal of Public Economics*, 85(1), 121–148.

- Duflo, E., & Saez, E. (2003a). The Role of Information and Social Interactions in Retirement Plan Decisions: Evidence from a Randomized Experiment*. *The Quarterly Journal of Economics*, 118(3), 815–842. <https://doi.org/10.1162/00335530360698432>
- Duflo, E., & Saez, E. (2003b). The Role of Information and Social Interactions in Retirement Plan Decisions: Evidence from a Randomized Experiment*. *The Quarterly Journal of Economics*, 118(3), 815–842. <https://doi.org/10.1162/00335530360698432>
- Dur, R., Fleming, D., van Garderen, M., & van Lent, M. (2021). A social norm nudge to save more: A field experiment at a retail bank. *Journal of Public Economics*, 200, 104443. <https://doi.org/10.1016/j.jpubeco.2021.104443>
- Eckert, S. J., & McCoy, M. (2024). The Benefits of Behavioral Nudges: Using Choice Architecture to Improve Decisions and Shape Outcomes in Retirement Savings Programs. *Journal of Financial Planning*, 37(3). <https://www.financialplanningassociation.org/learning/publications/journal/MAR24-benefits-behavioral-nudges-using-choice-architecture-improve-decisions-and-shape-outcomes-OPEN>
- Emmerson, C., & Cribb, J. (2019). *Requiring Auto-Enrollment: Lessons from UK Retirement Plans*. The IFS. <https://doi.org/10.1920/re.ifs.2024.0521>
- Evans, J. (2008). Dual-Processing Accounts of Reasoning, Judgment, and Social Cognition. *Annual Review of Psychology*, 59(1), 255–278. <https://doi.org/10.1146/annurev.psych.59.103006.093629>
- Festinger, L. (1954). *A Theory of Social Comparison Processes*. 7(2), 117–140.
- Gad-Harf, J. (2008). The Decline of Traditional Pensions, the Impact of the Pension Protection Act of 2006, and the Future of America’s Defined-Benefit Pension System. *Chicago-Kent Law Review*, 83(3), 1409.

- Geber, S., Tribelhorn, L., Hitchman, S. C., & Friemel, T. N. (2022). Dynamic norms for dynamic times? An experiment on the effects of dynamic and static norms messages on COVID-19 vaccination intention. *SCM Studies in Communication and Media*, 11(3), Article 3. <https://doi.org/10.5771/2192-4007-2022-3-453>
- Goda, G. S., Levy, M. R., Manchester, C. F., Sojourner, A., & Tasoff, J. (2020). Who is a passive saver under opt-in and auto-enrollment? *Journal of Economic Behavior & Organization*, 173, 301–321. <https://doi.org/10.1016/j.jebo.2019.08.026>
- Grinin, L., Grinin, A., & Korotayev, A. (2023). Global Aging: An Integral Problem of the Future. How to Turn a Problem into a Development Driver? In V. Sadovnichy, A. Akaev, I. Ilyin, S. Malkov, L. Grinin, & A. Korotayev (Eds.), *Reconsidering the Limits to Growth: A Report to the Russian Association of the Club of Rome* (pp. 117–135). Springer International Publishing. https://doi.org/10.1007/978-3-031-34999-7_7
- Hainmueller, J., Hangartner, D., & Yamamoto, T. (2015). Validating vignette and conjoint survey experiments against real-world behavior. *Proceedings of the National Academy of Sciences of the United States of America*, 112(8), 2395–2400. <https://doi.org/10.1073/pnas.1416587112>
- Hertwig, R., & Grüne-Yanoff, T. (2017). Nudging and Boosting: Steering or Empowering Good Decisions. *Perspectives on Psychological Science*, 12(6), 973–986. <https://doi.org/10.1177/1745691617702496>
- Hsee, C. K., & Weber, E. U. (1999). Cross-national differences in risk preference and lay predictions. *Journal of Behavioral Decision Making*, 12(2), 165–179. [https://doi.org/10.1002/\(SICI\)1099-0771\(199906\)12:2<165::AID-BDM316>3.0.CO;2-N](https://doi.org/10.1002/(SICI)1099-0771(199906)12:2<165::AID-BDM316>3.0.CO;2-N)

- Hummel, D., & Maedche, A. (2019). How effective is nudging? A quantitative review on the effect sizes and limits of empirical nudging studies. *Journal of Behavioral and Experimental Economics*, 80, 47–58. <https://doi.org/10.1016/j.socec.2019.03.005>
- Hwang, I. D. (2024). Behavioral aspects of household portfolio choice: Effects of loss aversion on life insurance uptake and savings. *International Review of Economics & Finance*, 89, 1029–1053. <https://doi.org/10.1016/j.iref.2023.07.027>
- Ingendahl, M., Hummel, D., Maedche, A., & Vogel, T. (2021). Who can be nudged? Examining nudging effectiveness in the context of need for cognition and need for uniqueness. *Journal of Consumer Behaviour*, 20(2), 324–336. <https://doi.org/10.1002/cb.1861>
- Jachimowicz, J. M., Duncan, S., Weber, E. U., & Johnson, E. J. (2019). When and why defaults influence decisions: A meta-analysis of default effects. *Behavioural Public Policy*, 3(2), 159–186. <https://doi.org/10.1017/bpp.2018.43>
- Jain, J., Walia, N., Singla, H., Singh, S., Sood, K., & Grima, S. (2023). Heuristic Biases as Mental Shortcuts to Investment Decision-Making: A Mediation Analysis of Risk Perception. *Risks*, 11(4), Article 4. <https://doi.org/10.3390/risks11040072>
- Johnson, E. J., Shu, S. B., Dellaert, B. G. C., Fox, C., Goldstein, D. G., Häubl, G., Larrick, R. P., Payne, J. W., Peters, E., Schkade, D., Wansink, B., & Weber, E. U. (2012). Beyond nudges: Tools of a choice architecture. *Marketing Letters*, 23(2), 487–504. <https://doi.org/10.1007/s11002-012-9186-1>
- Kahneman, D. (2011). *Thinking, fast and slow*. Farrar, Straus and Giroux.
- Kahneman, D., & Tversky, A. (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica*, 47(2), Article 2. <https://doi.org/10.2307/1914185>
- Kubik, J. D., Hong, H. G., & Stein, J. C. (2001). *Social Interaction and Stock Market Participation* (SSRN Scholarly Paper No. 274077). <https://doi.org/10.2139/ssrn.274077>

- Ladrón de Guevara Cortés, R., Tolosa, L. E., & Rojo, M. P. (2023). Prospect theory in the financial decision-making process: An empirical study of two Argentine universities. *Journal of Economics, Finance and Administrative Science*, 28(55), 116–133.
<https://doi.org/10.1108/JEFAS-12-2021-0272>
- Laibson, D. (1997). Golden Eggs and Hyperbolic Discounting. *The Quarterly Journal of Economics*, 112(2), 443–477.
- Lee, S. J., & Liu, J. (2023). Leveraging Dynamic Norm Messages to Promote Counter-Normative Health Behaviors: The Moderating Role of Current and Future Injunctive Norms, Attitude and Self-Efficacy. *Health Communication*, 38(6), 1071–1079.
<https://doi.org/10.1080/10410236.2021.1991638>
- Lessenich, S. (2007). Bernhard Ebbinghaus: Reforming Early Retirement in Europe, Japan and the USA. *KZfSS Kölner Zeitschrift für Soziologie und Sozialpsychologie*, 59(4), 723–725. <https://doi.org/10.1007/s11577-007-0089-8>
- Lim, W., Donnelly, C., & Khemka, G. (2019). *Investing for Retirement: How Loss Aversion Risk Preferences Naturally Leads to Greater Retirement Income Certainty* (SSRN Scholarly Paper No. 3426932). Social Science Research Network.
<https://doi.org/10.2139/ssrn.3426932>
- Lusardi, A., & Messy, F.-A. (2023). The importance of financial literacy and its impact on financial wellbeing. *Journal of Financial Literacy and Wellbeing*, 1(1), 1–11.
<https://doi.org/10.1017/flw.2023.8>
- Lusardi, A., & Mitchell, O. S. (2011). *Financial Literacy and Planning: Implications for Retirement Wellbeing* (Working Paper No. 17078). National Bureau of Economic Research. <https://doi.org/10.3386/w17078>

- Luukkanen, L., & Uusitalo, O. (2019). Toward Financial Capability—Empowering the Young. *Journal of Consumer Affairs*, 53(2), 263–295.
<https://doi.org/10.1111/joca.12186>
- Madrian, B. C., & Shea, D. F. (2000). *The Power of Suggestion: Inertia in 401(k) Participation and Savings Behavior* (Working Paper No. 7682; Issue 7682). National Bureau of Economic Research. <https://doi.org/10.3386/w7682>
- Madrian, B. C., & Shea, D. F. (2001). The Power of Suggestion: Inertia in 401(k) Participation and Savings Behavior*. *The Quarterly Journal of Economics*, 116(4), 1149–1187. <https://doi.org/10.1162/003355301753265543>
- Miles, D. (2023). Macroeconomic impacts of changes in life expectancy and fertility. *The Journal of the Economics of Ageing*, 24, 100425.
<https://doi.org/10.1016/j.jeoa.2022.100425>
- Modigliani, F. (1986). Life Cycle, Individual Thrift, and the Wealth of Nations. *The American Economic Review*, 76(3), 297–313.
- Mortensen, C. R., Neel, R., Cialdini, R. B., Jaeger, C. M., Jacobson, R. P., & Ringel, M. M. (2019). Trending Norms: A Lever for Encouraging Behaviors Performed by the Minority. *Social Psychological and Personality Science*, 10(2), 201–210.
<https://doi.org/10.1177/1948550617734615>
- Moya-Ponce, C., & Madrazo-Lemaroy, P. (2023). Beliefs that provide a foundation for heuristics and biases in financial decision-making. *Cuadernos de Gestión*, 23(2), Article 2. <https://doi.org/10.5295/cdg.221703pm>
- Munnell, A., Rutledge, M. S., & Webb, A. (2014). *Are Retirees Falling Short? Reconciling the Conflicting Evidence* (SSRN Scholarly Paper No. 2530024). Social Science Research Network. <https://doi.org/10.2139/ssrn.2530024>

- Nolan, J. M., Schultz, P. W., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2008). Normative Social Influence is Underdetected. *Personality and Social Psychology Bulletin*, 34(7), 913–923. <https://doi.org/10.1177/0146167208316691>
- O'Donoghue, T., & Rabin, M. (2015). Present Bias: Lessons Learned and to Be Learned. *American Economic Review*, 105(5), 273–279. <https://doi.org/10.1257/aer.p20151085>
- OECD. (2019). *Pensions at a Glance 2019: OECD and G20 Indicators*. Organisation for Economic Co-operation and Development. https://www.oecd-ilibrary.org/social-issues-migration-health/pensions-at-a-glance-2019_b6d3dcfc-en
- OECD. (2023). *Pensions at a Glance 2023*. <https://www.oecd-ilibrary.org/content/publication/678055dd-en>
- Rieger, M. O., Wang, M., & Hens, T. (2015). Risk Preferences Around the World. *Management Science*, 61(3), 637–648.
- Robalino, J. D., Fishbane, A., Goldstein, D. G., & Hershfield, H. E. (2023). Saving for retirement: A real-world test of whether seeing photos of one's future self encourages contributions. *Behavioral Science & Policy*, 9(1), 1–9. <https://doi.org/10.1177/23794607231190607>
- Samuelson, W., & Zeckhauser, R. (1988). Status quo bias in decision making. *Journal of Risk and Uncertainty*, 1(1), 7–59. <https://doi.org/10.1007/BF00055564>
- Sparkman, G., & Walton, G. M. (2019). Witnessing change: Dynamic norms help resolve diverse barriers to personal change. *Journal of Experimental Social Psychology*, 82, 238–252. <https://doi.org/10.1016/j.jesp.2019.01.007>
- Sunstein, C. R., & Reisch, L. A. (2019). *Trusting Nudges: Toward A Bill of Rights for Nudging*. Routledge. <https://doi.org/10.4324/9780429451645>
- Thaler, R. H. (2018). Nudge, not sludge. *Science*, 361(6401), 431–431. <https://doi.org/10.1126/science.aau9241>

- Thaler, R. H., & Benartzi, S. (2004). Save More Tomorrow™: Using Behavioral Economics to Increase Employee Saving. *Journal of Political Economy*, 112(S1), S164–S187.
<https://doi.org/10.1086/380085>
- Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decisions about health, wealth, and happiness* (pp. x, 293). Yale University Press.
- Trope, Y., & Liberman, N. (2010). Construal-level theory of psychological distance. *Psychological Review*, 117(2), 440–463. <https://doi.org/10.1037/a0018963>
- Tversky, A., & Kahneman, D. (1973). Availability: A heuristic for judging frequency and probability. *Cognitive Psychology*, 5(2), 207–232. [https://doi.org/10.1016/0010-0285\(73\)90033-9](https://doi.org/10.1016/0010-0285(73)90033-9)
- van den Akker, M., & Sunstein, C. R. (2023). *Do People Like Financial Nudges?* (SSRN Scholarly Paper No. 4636905). <https://doi.org/10.2139/ssrn.4636905>
- Van Dessel, P., Boddez, Y., & Hughes, S. (2022). Nudging societally relevant behavior by promoting cognitive inferences. *Scientific Reports*, 12(1), Article 1.
<https://doi.org/10.1038/s41598-022-12964-1>
- Voudouri, A., Białek, M., & De Neys, W. (2024). Fast & slow decisions under risk: Intuition rather than deliberation drives advantageous choices. *Cognition*, 250, 105837.
<https://doi.org/10.1016/j.cognition.2024.105837>
- Wagler, K. R., & Wells, T. T. (2024). Effects of personality and gender on nudgeability for mental health-related behaviors. *Current Opinion in Psychology*, 60, 101938.
<https://doi.org/10.1016/j.copsy.2024.101938>
- Xie, Y., Hwang, S., & Pantelous, A. A. (2017). *Loss Aversion around the World: Empirical Evidence from Pension Funds* (SSRN Scholarly Paper No. 2757082). Social Science Research Network. <https://doi.org/10.2139/ssrn.2757082>

Supplementary Information

Table S1

Descriptives Non-Categorical Individual Characteristics

	<i>M</i>	<i>SD</i>	Min.	Max.
Age	35	11	18	65
Salary Satisfaction	4.9	1.3	1.0	7.0
Work Satisfaction	5.5	1.1	1.0	7.0

Note. $N = 1,361$.

Table S2

Frequencies Categorical Individual Characteristics

	<i>n</i>	%
Sex		
Female	503	37.0
Male	858	63.0
Highest Educational Degree		
No diploma	36	2.6
Lower than Higher Secondary	21	1.5
Higher Secondary Diploma	268	19.7
University College Diploma	478	35.1
University Diploma	558	41.0
Salary		
< €1750	144	10.6
€1751- €2000	329	24.2
€2001-€2500	461	33.9
€2501-€3500	315	23.1
> €3500	112	8.2

Note. $N = 1,361$. Salary represents monthly net income in euros.

5

Annuity vs. Lump Sum: A Mega Study on Occupational Pension Uptake Decisions

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Abstract

In a comprehensive 24-condition between-subjects online vignette study involving 15,593 participants, we investigated the effectiveness of various nudging interventions, including defaults, pre-commitment strategies, evaluative labels, social norms, and their combinations, on annuity uptake decisions within the occupational pension scheme. Participants decided how to allocate their pension funds between a lump sum and an annuity using a continuous decision slider, offering a more flexible alternative to traditional binary choices. Our findings revealed a small but statistically significant effect of pre-commitment strategies on annuitization ($g = 0.05$). However, contrary to expectations, all other interventions (defaults, social norms, evaluative labels, and their combinations) showed no significant effect on annuity uptake. Notably, we observed a consistent decision pattern across all conditions. On average, across all conditions, 51.2% of participants opted for less than 5% annuity uptake, 34.5% chose a mix, with a significant peak of 13% at exactly 50% annuity uptake, and 14.3% selected more than 95% annuity. This clustering around round numbers suggests a "round number bias" influenced by the 0–100% continuous scale used, where participants gravitated towards cognitively straightforward, salient options. These findings align with recent debates questioning the general effectiveness of nudging interventions, particularly in complex financial decisions, often involving deeply rooted preferences. The present study highlights the limitations of nudges in shifting behavior as our study also underscores the need for a better understanding of the driving forces behind annuity uptake rationales to effectively influence annuity uptake decisions.

Statement of Relevance

Understanding how individuals make decisions about annuitizing their occupational retirement savings is crucial for policymakers and financial institutions aiming to promote long-term financial security. The present study provides valuable insights into the limited effectiveness of behavioral nudges (defaults, pre-commitment strategies, evaluative labels, and their combinations) in influencing annuitization decisions. Despite the growing use of these interventions in various financial domains, our findings suggest that individuals may resist external nudges when faced with complex, high-stakes decisions like retirement planning. Moreover, the identification of a substantial portion of the population who seems open towards partial or full annuitization highlights an important market for tailored annuity retirement products. These insights can shape the design of more effective policy interventions and financial tools that take into account personal preferences, financial literacy, and risk tolerance. The present study not only advances academic understanding of behavioral decision-making in retirement planning but also provides actionable recommendations for improving the design of retirement systems and financial advice platforms.

Introduction

Global life expectancy has doubled over the last two centuries, with the average reaching over 70 years in 2021, compared to just 29.3 years in 1850 (Dattani et al., 2023). The OECD (2023) projects that by 2050, the proportion of individuals aged 65 and over will further increase from 18% in 2022 to 27%, outnumbering those aged 15–24. In addition to an aging population, the fertility rate in the EU has dropped to an average of 1.53 children per woman, significantly below the replacement level of 2.1 needed to maintain population stability, resulting in nearly half as many children being born in 2022 compared to six decades ago (Craig, 1994; Eurostat, 2024).

These birth rates, combined with the demographic shift towards an aging population have placed immense pressure on the public pension systems globally. Consequently, more people will spend more years out of the workforce, while the pool of contributors to the pension system shrinks. Combined with adverse budgetary conditions (Bayar, 2018) and persistently low interest rates (Bielecki et al., 2020), this trend continues to lead to a declining ratio between the retirement income (i.e., the sum of pillar I, II, and III pensions¹) and the employment income at retirement (OECD, 2019). This trend has introduced concerns about the sustainability of pension systems across Europe. Several studies suggest that a part of the solution lies in stimulating choice for annuity products to mitigate shortages in old age (Benartzi et al., 2011; Inkmann et al., 2008).

Annuities are financial products that offer a solution for households and individuals to guard against longevity risk by converting a portion of their wealth into a guaranteed income stream until death. Rational choice theory predicts that individuals facing uncertainty about their lifespan, should always opt for annuities when nearing retirement to ensure financial stability. (Davidoff et al., 2005; Yaari, 1965). However, empirical evidence consistently

¹ European pension systems often include three pillars: state pensions (Pillar I), employer-sponsored pensions (Pillar II), and voluntary personal savings (Pillar III), with terminology varying by country.

shows that few retirees actively choose to ever annuitize a significant part of their wealth, a phenomenon better known as the "annuity puzzle" (Modigliani, 1986). This behavior remains poorly explained by traditional economic models, which assume rational decision-making.

Pension regulators globally implement diverse retirement payout policies, from mandatory annuitization to flexible approaches, influencing annuity uptake and income adequacy. For instance, with its high annuity adoption, the Netherlands achieves a 93.2% net replacement rate for average-income households (OECD, 2023; Rusconi, 2008), while neighboring Belgium's less developed annuity market yields 60.9% (OECD, 2023). This disparity mainly stems from different default options in the work-related take-up decision: the Netherlands defaults to annuity conversion, while Belgium defaults to lump sum payouts (Dillingh & Zumbuehl, 2021; OECD, 2021).

Research indicates that mandates and compulsory schemes often fall short of optimal outcomes for all retirees (Beshears et al., 2014). Given the complexity and individuality of retirement needs, there is substantial value in exploring methods to encourage annuity uptake while preserving freedom of choice.

In the current study, we aim to address the universally acknowledged annuity puzzle through a large online vignette study, using data from a European country (Belgium). In contrast to real-life settings where pension choices are typically limited to a binary decision between a lump sum and an annuity, this study reframes the work-related Pillar II pension take-up decision as a continuous choice. To this extent, we asked participants what percentage of their work-related pension they want to annuitize. Utilizing a mega-study design, we examine the effects of defaults, social norms, evaluative labels, pre-commitments, and combined interventions in an online choice environment that is presented to thousands of people. Additionally, for the purpose of describing our study sample, we collect data on

general demographics, financial literacy, Big Five personality traits, self-efficacy, and self-control.

Solving the Annuity Puzzle

Despite the clear advantages of annuities for securing lifetime income and hedging against longevity risk, many people are reluctant to purchase them (Modigliani, 1986). Economic theories propose several rational explanations for this annuity puzzle, such as bequest motives (Lockwood, 2012), uncertainty about life expectancy (Edwards, 2008; Hurd & McGarry, 1995; Wu et al., 2015), low financial self-efficacy (Baláž, 2023), financial (annuity) literacy (Brown, 2007; Goedde-Menke et al., 2014; Lusardi & Mitchell, 2011), the irreversible character of annuities (Sinclair & Smetters, 2004), pre-existing state pension annuitization through social security (Dushi & Webb, 2004), adverse selection (Finkelstein & Poterba, 2004), market incompleteness (Davidoff et al., 2005), pricing considerations (Mitchell et al., 1999; Wettstein et al., 2021), and the option value of delaying annuitization (Milevsky & Young, 2007). However, none of these accounts can fully explain the observed non-purchase behavior of annuities in real-world markets through rational utility based models (Benartzi et al., 2011; Dushi & Webb, 2004).

Financial decisions, including those about annuities, are seldom made in a vacuum. While traditional economic models offer valuable insights, they often overlook the substantial influence of psychological factors (that may be economically irrational or suboptimal), cognitive biases, emotional responses, and contextual forces that shape individual choices (Benartzi et al., 2011). Over the last decades, behavioral economics has emerged as a crucial lens to examine and explain the annuity puzzle, offering novel insights into its psychological underpinnings.

Beyond Rationality

Central to the field of behavioral economics, lies the dual system theory, which distinguishes between two modes of thinking: the intuitive and automatic "System 1," and the deliberative and effortful "System 2" (Kahneman, 2011). System 1 operates rapidly and emotionally, using heuristics, while System 2 is thought to be slower, logical, and capable of complex reasoning. Although System 2 is often ideal for complex decisions, it demands significant cognitive resources and depletes easily (Baumeister et al., 1998).

However, recent theoretical developments have challenged this strict dichotomy, suggesting a more nuanced interplay between intuitive and deliberative processes (De Neys, 2023). Rather than viewing System 1 as inherently biased and System 2 as necessarily logical, evidence indicates that intuitive processing can generate multiple competing responses simultaneously, both heuristic-based and logic-based (Bago & De Neys, 2019; Voudouri et al., 2024). Even in complex financial decisions like annuitization, individuals may show sophisticated intuitive processing that incorporates both immediate emotional responses and implicit sensitivity to long-term considerations (De Neys, 2006, 2021).

These novel insights into the underlying mechanisms of the dual process theoretical framework helps explain why observed behavioral patterns in financial decision-making cannot be reduced to simple System 1 biases requiring System 2 correction. While people may exhibit tendencies like loss aversion and present bias (Kahneman & Tversky, 1979), they often show decreased confidence when making seemingly biased choices, suggesting an intuitive awareness of competing considerations (De Neys, 2023). Understanding financial decision-making thus requires examining how different types of intuitions, both short-term focused and long-term oriented, compete and interact to influence choices (Van Dessel et al., 2022).

Applying this theoretical framework to complex financial decisions like annuitization reveals important insights about decision-making patterns (Benartzi & Thaler, 2013). While observed behaviors like loss aversion and present bias might superficially suggest simple reliance on cognitive shortcuts (Kahneman & Tversky, 1979), the reality appears more nuanced. When facing annuitization decisions, individuals likely experience competing intuitive pulls between immediate financial control and long-term security (Van Dessel et al., 2022). Rather than merely defaulting to biased System 1 responses, people appear to engage in sophisticated intuitive processing that incorporates both immediate and long-term considerations, even if they ultimately favor more immediate benefits. Understanding financial decisions through this lens of competing intuitions, rather than simple bias correction, has important implications for how we design interventions to support better financial decision-making.

To address these cognitive tendencies, behavioral economists employ "nudges". These nudges are subtle changes in choice architecture that can guide individuals towards better decisions without restricting freedom of choice (Thaler & Sunstein, 2008). Nudging interventions have shown considerable promise in influencing financial decision-making. For instance, Madrian & Shea (2001) found that changing the default option in 401(k) plans from non-enrollment to automatic enrollment, dramatically increased participation rates from 37% to 86%, showcasing the power of default effects. Thaler & Benartzi's (2004) further expanded on this seminal work with the Save More Tomorrow™ program. This occupational pension savings program employed a pre-commitment strategy where employees pledged future salary increases to retirement savings, resulting in nearly quadrupled average savings rates from 3.5% to 13.6% over 40 months. In the realm of investment decisions, Beshears et al. (2015) revealed that social reference information can have nuanced effects. Indeed, when low-saving employees were informed about the high savings rates of their peers, instead of

motivating them to save more, their savings rates decreased by 0.11 percentage points.

However, when peer information was thoughtfully framed to emphasize positive behaviors and achievable goals, it led to an increase in savings rates of up to 1.1 percentage points.

Sunstein (2014) provides a comprehensive catalog of ten key distinct nudges, including defaults, social norms, pre-commitment strategies, implementation intentions, and simplification. These nudges work by influencing the relative strength of competing intuitions and facilitating productive inferential processes, rather than simply exploiting cognitive shortcuts or forcing deliberative engagement (De Neys, 2023; Van Dessel et al., 2022). Building on the work of Sunstein (2014), Mertens et al. (2022) categorized these nudges into three broad categories (see Table 1): decision structure (DS), decision assistance (DA), and decision information (DI). This categorization allows for a more nuanced understanding of how different types of nudges operate and their relative effectiveness across various domains.

First, DS interventions, which alter the arrangement of choice options (like changing choice defaults, altering range or composition of options, consequences or option-related effort) show the strongest effects on behavior change ($d = 0.54$). In the finance domain, these interventions demonstrate an effect size of $d = 0.33$. Second, DA interventions (like providing reminders or facilitating commitment), which aid in follow-through with intentions, show a moderate effect ($d = 0.28$), with a finance-specific effect size of $d = 0.21$. Lastly, DI interventions (like providing social reference points, making information visible or adapting already available information attributes), which modify how information is presented, demonstrate an overall effect size of $d = 0.34$, with a finance-specific effect size of $d = 0.23$ (Mertens et al., 2022).

In the present study, our very large sample allows the simultaneous test of several nudge strategies to the context of work-related annuity take-up decisions, spanning every intervention category as proposed by Mertens et al. (2022). Table 1 provides an overview of

the specific nudges employed, their category, their potential effects on financial decision-making, relevant references, and their implementation in this study.

Table 1
An overview of the nudges implemented in the current study

Category	Nudge	Description and Potential Effect on Financial Choice Behavior	Key references	Implementation in Current Study
DS	Defaults	Pre-selected options significantly influence choices due to inertia and status quo bias. Can dramatically affect retirement savings and annuitization rates.	Madrian & Shea (2001); Varying default annuitization rates Cronqvist et al. (2018)	(0%, 50%, 100%)
DS	Reframing Binary Decisions	Altering the presentation of choices from binary to continuous can reduce ambiguity aversion and engage more deliberative thinking.	Brown et al. (2008); Agnew et al. (2008)	Reframing annuity choice from binary (annuity vs. lump sum) to continuous (percentage to annuitize)
DA	Pre-commitment reminders	Making decisions about future behavior addresses present bias and promotes long-term planning. Reminders on "if-then" plans bridge the gap between intentions and actions.	Thaler & Benartzi (2004); Beshears et al. (2015) Gollwitzer & Sheeran (2006); Soman & Zhao (2011)	Asking participants to state expected monthly needs in retirement and reminding them of their stated monthly needs during the annuity choice task
DI	Social Reference	Providing information about peers' behavior can influence decisions through social comparison and conformity.	Brown et al. (2008); Duflo & Saez (2003)	Informing participants about average Belgian pensioner's monthly expenses
DI	Evaluative Risk Labels	Simplified, visual risk assessments reduce cognitive load and leverage intuitive thinking.	Bateman et al. (2016); Vlaev et al. (2009)	Color-coded risk score indicating adequacy of chosen annuitization level

Note. DS= Decision Structure; DA= Decision Assistance; DI= Decision Information.

The interventions we selected for the current study, are based on their proven effectiveness in other domains of human decision-making, their potential influence in financial decision-making, and practical considerations. By employing these diverse nudging strategies, we aim to comprehensively examine their potential to address the annuity puzzle and influence annuitization decisions.

The Mega-Study Approach

The social and behavioral sciences have recently faced a replication crisis, challenging the reliability of many established findings, including those in the field of nudging (DellaVigna & Linos, 2022; Maier et al., 2022; Open Science Collaboration, 2015). In response, the mega-study approach has emerged as a promising methodology for advancing behavioral science.

Mega-studies are large-scale field experiments testing multiple treatments simultaneously using a common, objectively measured outcome (Duckworth & Milkman, 2022). This approach addresses limitations in traditional research by allowing direct and relative ‘apples-to-apples’ comparisons of intervention effectiveness, mitigating type I errors² and publication bias (Laitin et al., 2021; Malhotra & Simonovits, 2014) and eliminating type II errors through large statistical power. Such direct comparisons of multiple study arms make null findings particularly relevant, as they reveal the boundaries of intervention effectiveness and prevent wasted resources on replicating unpublished null-studies. By testing numerous interventions concurrently, mega-studies enhance efficiency and accelerate scientific progress (Benartzi et al., 2017). Recent examples across various domains of high societal impact include studies on increasing exercise (Milkman et al., 2021), encouraging flu vaccinations (Milkman et al., 2022), and promoting COVID-19 vaccination follow-through (Dai et al., 2021; Milkman et al., 2024).

Current Study

The current study investigates the effectiveness of various nudging interventions on annuity uptake decisions in work-related pension decisions. Employing a mega-study-inspired design, we conduct a large-scale online vignette study testing 24 conditions. We explore defaults, pre-commitment strategies, evaluative labels, social norms, and their combinations,

²The incorrect rejection of a true null hypothesis, commonly known as a false positive.

while also controlling for gender and age. Our aim is to address the annuity puzzle by enabling direct comparisons of intervention efficacy in influencing occupational pension take-up decisions. Rather than simulating the real-world decision as a binary choice between a lump-sum payout and monthly annuitization, participants were given a more flexible, continuous option. This approach allowed for a more nuanced exploration of participants' preferences, giving them the freedom to choose any proportion of each option rather than being forced into a binary decision. By examining strategies across categories defined by Mertens et al. (2022), we provide a comprehensive comparison of behavioral interventions. Table S1 of the Supplementary information provides a complete study overview of the conditions. To our knowledge, this is the first study to apply the mega-study-inspired approach to explore the annuity puzzle, contributing significantly to both behavioral science literature and practical retirement policy.

When controlled for age, sex, and the other types of decision interventions, we aim to address the following research questions:

RQ1: How do DS interventions (defaults), DA interventions (pre-commitment strategy), and DI interventions (in terms of (1) social norms and (2) evaluative risk labels) independently influence annuitization?

RQ2: How do multi-way interactions between DS, DA, and DI interventions affect annuitization?

RQ2.1: Do DA interventions moderate the DS–annuitization relationship?

RQ2.2: Do DI interventions (in terms of (1) social norms and (2) evaluative risk labels) moderate the DS–annuitization relationship?

RQ2.3: Do DA and DI interventions (in terms of (1) social norms and (2) evaluative risk labels) interact to influence DS–annuitization?

RQ2.4: Do DI interventions (evaluative risk labels) interact with DI interventions (social norms) on annuitization?

RQ2.5: Do three-way interactions among DS, DA, and DI interventions affect annuitization?

RQ2.6: Do four-way interactions among DS, DA, and both DI type interventions affect annuitization?

Method

Participants

Calls for participation were distributed via social media, national newspapers, social secretaries, and university hospitals to ensure a representative sample of the Belgian adult population. Inclusion criteria required participants to be aged between 18 and 66 years old, and not pensioned. The initial sample consisted of 32,067 entries. Incomplete data entries, entries with the pre-selected birth year of 1970 (a significant outlier), and non-binary gender entries³ were also excluded, resulting in a final sample comprising 15,593 participants. The mean age of participants was 54 years ($SD = 12.85$, 42.8% female). Participants reported a mean subjective life expectancy of 85.86 years ($SD = 8.628$). A comprehensive summary of the non-categorical descriptive statistics of the study population's individual characteristics can be found in Table S2 of the Supplementary Information.

As compensation, participants who completed the full questionnaire received an automated personalized 8-page research report. This report provided their personality profile, based on their answers on the mini-IPIP scales compared Belgian norm data from Donnellan et al. (2006), and their statistical probability of reaching 80 and 90 years, based on national longevity statistics from the IABE institute⁴ (Antonio et al., 2020). This compensation

³ Non-binary gender data were excluded due to insufficient sample size, preventing robust analysis

⁴ A membership organization for the actuarial profession in Belgium.

strategy was designed to encourage truthful responses by offering personalized, valuable information to participants.

Design and Procedure

This study employed a randomized 3x2x2x2 between-subjects design (See Figure 1). Upon visiting the study website, participants were presented with a general introduction, and got informed about the voluntary and anonymous nature of the study, with a personalized research report serving as the sole participation incentive. After explicit agreement to the informed consent, participants interacted with a chatbot through a mobile interface designed to simulate a smartphone messaging experience (see Figure S1, for an example of the study interface). Subsequently, participants were asked to provide general demographic information (birth year, gender, and income).

The core of the experiment involved a vignette that described a retirement scenario. Participants were asked to imagine that they were 66 years old, about to retire, and eligible for a government-provided pension of €1,500 per month⁵. Additionally, they were informed that they had built up a €100,000 occupational pension fund through joint employer-employee contributions during their career. Subsequently, participants were asked to decide how they would like to take out this €100,000 pension fund using an interactive interface with two linked sliders (as illustrated in Panel D of Figure S1, and in Figure S3). The first slider indicated what percentage of the €100,000 they wanted to convert into monthly lifelong payments (annuitization), while the second slider automatically showed the remaining percentage they would receive as a one-time payment (lump sum). For example, moving the annuitization slider to 50% would result in €50,000 being converted to monthly payments of €246 for life, starting at the retirement age of 67, with the remaining €50,000 received as a lump sum. The sliders allowed for continuous adjustment between full annuitization (100% =

⁵ A single, Belgian retiree reviving the minimum pension in January 2023 receives an average statutory pension income of €1,574 (Belgian Federal Pension Service, 2023).

€492 monthly for life, no lump sum) and full lump sum (0% = €100,000 one-time payment at retirement age, no monthly income). This allowed participants to choose any combination of monthly and one-time payments, with both percentages always totaling 100%.⁶

Implementation of Interventions

(1) Default Settings (DS). Participants encountered one of three initial slider positions (see Figure S3): 0% annuitization (0-100), 100% annuitization (100-0), or equal distribution (50-50). These defaults served as participants' starting points, from which they could freely adjust their allocation.

(2) Pre-commitment (DA). In conditions with pre-commitment (see Figure S4), before making their allocation decision, participants were asked to estimate the additional monthly income they believed they would need on top of their government pension during retirement. This estimate was later used as a visual reference point on the sliders during their decision-making process on annuitization allocation.

(3) Social Norms (DI). In conditions with social norm information (see Figure S4), participants were shown that the average monthly expenses of a Belgian retiree amounted to €1,704. This reference point was indicated on the sliders to anchor participants' expectations regarding their retirement income needs.

(4) Risk Labels (DI). In conditions with evaluative risk labels (see Figure S5), participants received dynamic feedback on their choices through color-coded risk scores (A to D). These labels updated in real-time as participants adjusted their allocation, with greener scores (A) indicating better protection against longevity risk through higher annuitization

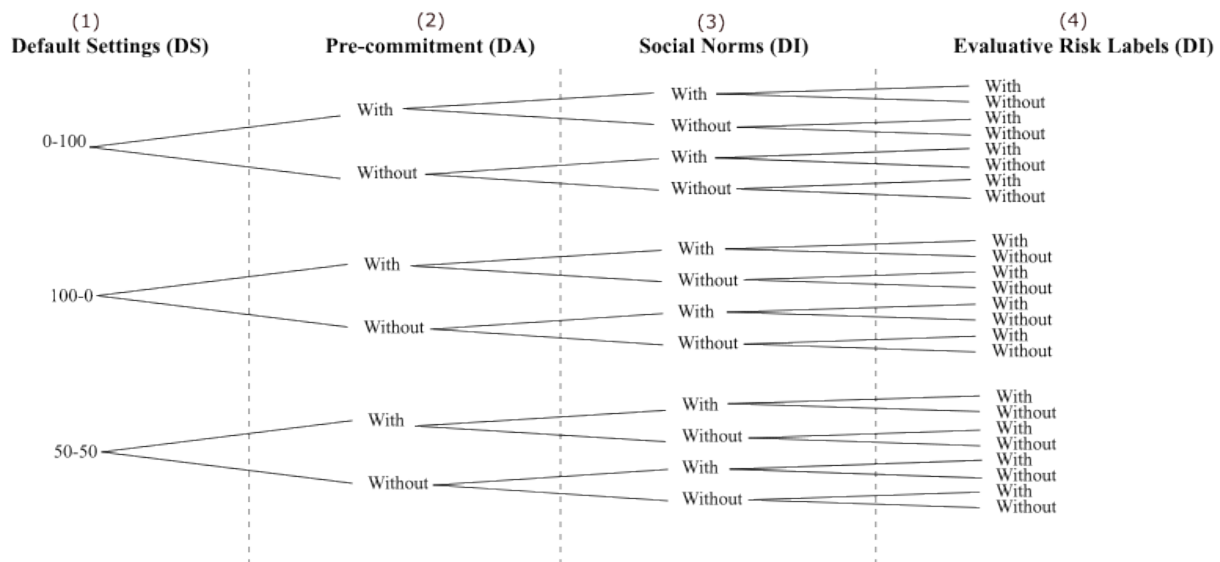
⁶ These monthly payment rates, while more generous than typical market rates, were deliberately calibrated to be actuarially advantageous beyond age 84 (17 years post-retirement). This design ensures annuitization is clearly economically advantageous for those with average life expectancy, making the persistent low annuitization rates (the "annuity puzzle") more striking and providing a conservative test of our behavioral interventions. Figure S2 illustrates these economic dynamics by simulating wealth trajectories under different distribution choices, demonstrating the annuity's increasing advantage beyond the break-even age.

levels, and redder scores (D) warning about increased risk from higher lump-sum percentages.

Figure 1 summarizes the $3 \times 2 \times 2 \times 2$ design and depicts all 24 conditions.

Figure 1

Study design ($3 \times 2 \times 2 \times 2$)



Note. Our $3 \times 2 \times 2 \times 2$ design showing four manipulated variables: Default Settings (DS)(1), Pre-commitment (DA)(2), Social Norms (DI)(3), and Evaluative Risk Labels (DI)(4), resulting in 24 unique experimental conditions.

Analyses

Descriptive statistics (see Table S2 and S3) were calculated for non-categorical individual characteristics (e.g., age), while frequencies were reported for categorical variables (e.g., gender).

To address our research questions, we employed a univariate linear regression using the General Linear Model (GLM) procedure. The dependent variable was annuitization (the percentage allocated to the annuity option), with the decision intervention variables, age, and sex as independent variables.

Significant main effects (RQ1) were further investigated using Pairwise Comparisons to evaluate the differences in estimated marginal means, controlling for other predictors in the model. When decision intervention variables consisted of more than two categories (e.g., information interventions), a Bonferroni correction was applied to control for multiple comparisons. Additionally, we calculated Hedges' g to report effect sizes, as it is particularly suitable for comparing groups of unequal sizes.

Significant interactions (RQ2 and its sub-RQ's) were explored through Bonferroni-adjusted Pairwise Comparisons of estimated marginal means, controlling for other predictors, and Hedges' g was again used to measure effect sizes across groups.

Ethical Considerations

The study received formal approval from the university ethics board (reference code 2021/138 FWO project number S006721N). All participants provided informed consent after being informed about the study's purpose, voluntary nature, and their right to withdraw at any time.

Data was collected anonymously, with no personally identifiable information linked to participants' responses. Email addresses for personalized reports were stored separately to ensure privacy. The study complied with GDPR regulations, ensuring secure and responsible data handling.

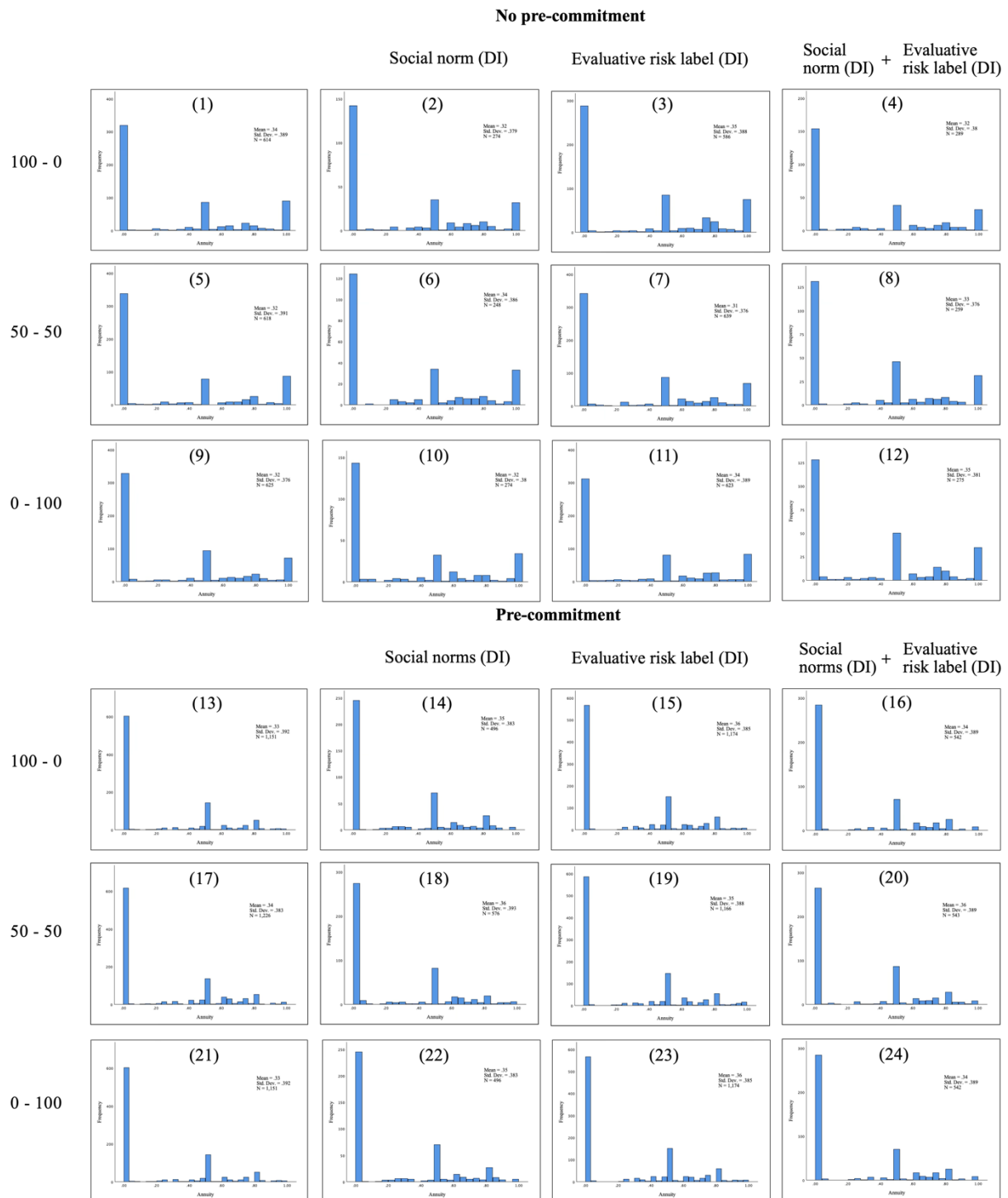
Minimal risks were involved, as participants only engaged with hypothetical retirement scenarios.

Results

We refer to Table 2 for the detailed results regarding the degrees of freedom, and significance levels of the (interaction) effects of the different decision interventions on annuitization. All (interaction) effects are controlled for age, sex, and the other types of decision interventions in the linear model. Given the large sample size and non-normal

distribution of annuitization choices, we validated our findings using non-parametric Tobit regression model, which yielded consistent results.

Figure 2 presents frequency distributions of annuitization choices (0-100%) for conditions without and with pre-commitment. Histograms are organized by default settings (100-0, 50-50, 0-100) and decision information interventions (nothing, social norms, evaluative risk labels, combined).

Figure 2*Distribution of Annuity Choices Across Experimental Conditions*

Note. Frequency distributions by default settings (rows: 100-0, 50-50, 0-100) and decision information (columns: nothing, social norm, evaluative risk label, combined) for conditions without pre-commitment (top panel) and with pre-commitment (bottom panel). Numbers (1-24) correspond to conditions in Table S1. M = mean percentage, SD = standard deviation, N = sample size.

For RQ1, we investigated how do DS interventions (defaults), DA interventions (pre-commitment strategy), and DI interventions (in terms of (1) social norms and (2) evaluative risk labels) independently influence annuitization. GLM analysis indicates a significant effect of DA interventions on annuitization ($g = 0.05$). Pairwise Comparisons reveal that individuals who were exposed to a pre-commitment strategy ($M = .36$, $SE = .004$, 95% CI [.35, .36]) opt to annuitize a slightly higher percentage of their work-related pension than individuals who were not exposed to a pre-commitment strategy ($M = .34$, $SE = .01$, 95% CI [.32, .35]). No significant effect is found for DS interventions, and DI interventions in terms of (1) social norms and (2) evaluative risk labels. For an overview of the pairwise comparisons' results, see Table 3.

For RQ2, we examined how multi-way interactions between DS, DA, and DI interventions affect annuitization. For RQ2.1, no significant interaction effect was found between DS and DA interventions on annuitization. For RQ2.2, results showed non-significant interaction effects between DS interventions and both types of DI interventions (social norms and evaluative risk labels). For RQ2.3, we found no significant interaction effects between DA interventions and either type of DI interventions (social norms and evaluative risk labels). For RQ2.4, DI interventions in terms of evaluative risk labels did not significantly interact with DI interventions in terms of social norms on annuitization. For RQ2.5, none of the three-way interactions between DS interventions, DA interventions, and DI interventions (both social norms and evaluative risk labels) were significant. For RQ2.6, the four-way interaction between DS interventions, DA interventions, and both types of DI interventions was non-significant.

Table 2*Results Tests of Between-Subjects Effects*

(Interaction) Effect Decision Interventions	df	F	Sig.	RQ
DS	2	0.48	.616	1
DA	1	8.56	.003**	1
Social Norms (DI)	1	0.22	.643	1
Evaluative Risk Labels (DI)	1	1.71	.191	1
DS * DA	2	0.62	.538	2
DS * Social Norms (DI)	2	1.40	.247	3
DS * Evaluative Risk Labels (DI)	2	0.54	.582	3
DA * Social Norms (DI)	1	0.18	.670	4
DA * Evaluative Risk Labels (DI)	1	0.17	.679	4
Social Norms (DI) * Evaluative Risk Labels (DI)	1	0.22	.636	5
DS * DA * Social Norms (DI)	2	1.18	.306	6
DS * DA * Evaluative Risk Labels (DI)	2	0.77	.462	6
DS * Social Norms (DI) * Evaluative Risk Labels (DI)	2	0.01	.991	6
DA * Social Norms (DI) * Evaluative Risk Labels (DI)	1	0.03	.865	6
DS * DA * Social Norms (DI) * Evaluative Risk Labels (DI)	4	0.49	.631	7

Note. ** $p < .010$. df = degrees of freedom. RQ = research question. The dependent variable concerns annuitization. $df_{\text{error}} = 15,567$. Controlled for age and sex. DS= Decision Structure, DA= Decision Assistance, DI= Decision Information.

Table 3

Estimates Pairwise Comparisons DS, DA and DI (in Terms of Social Norms and Evaluative Risk Labels) Interventions

Decision Interventions	<i>M</i>	<i>SE</i>	95% Confidence Interval	
			Lower Bound	Upper Bound
DS				
0-100	.34	.01	.33	.35
100-0	.35	.01	.34	.36
50-50	.34	.01	.33	.36
DA**				
No Pre-Commitment	.34	.01	.32	.35
Pre-Commitment	.36	<.01	.35	.36
DI – Social Norms				
No Social Norms	.34	.01	.34	.35
Social Norms	.35	.01	.34	.36
DI – Evaluative Risk Labels				
No Evaluative Risk Labels	.34	.01	.33	.35
Evaluative Risk Labels	.35	.01	.34	.36

Note. The means represent the estimated marginal means (i.e., controlled for age and sex).

**A significant effect on annuitization is found for decision assistance interventions ($p < .010$). Adjusted R Squared = .02.

Discussion

Despite numerous economic theories addressing the 'annuity puzzle', a clear explanation for why retirees avoid annuitization remains elusive, with existing theories failing to fully account for observed behaviors across diverse contexts (Agnew et al., 2008; Beshears et al., 2014; Brown et al., 2008a; Dushi & Webb, 2004). This study explores the influence of Decision structure (DS) interventions (defaults), Decision Assistance (DA) interventions (pre-commitment strategies), Decision Information (DI) interventions (in terms of (1) social norms and (2) evaluative risk labels), and their combinations on the decision to allocate a portion of

their occupational pension funds towards annuitization. We found that DA interventions had a small but significant effect on annuitization ($g = 0.05$), with participants exposed to a pre-commitment strategy opting to annuitize a higher percentage of their pension compared to those not exposed. In contrast, DS and DI interventions did not yield significant effects on annuitization. Furthermore, no significant interaction effects were found between the different types of interventions and annuitization for RQ2 nor its sub-RQ's, suggesting that these interventions operated independently rather than interacting to influence decision-making.

Effectiveness of Pre-Commitment Strategies

The significant effect of pre-commitment strategies on annuitization supports the existing literature, which highlights the power of commitment devices in promoting long-term behavioral outcomes, such as financial planning (Ashraf et al., 2006; Thaler & Benartzi, 2004). By encouraging individuals to commit to future goals, pre-commitment may help overcome present bias, often leading individuals to prioritize immediate needs over long-term security (O'Donoghue & Rabin, 2015). However, the (very) small effect size indicates that while pre-commitment nudges can be effective, their impact may be limited in the context of annuitization decisions. This suggests that additional or alternative interventions may be necessary to produce more substantial changes in behavior.

Recent theoretical developments in understanding commitment devices offer deeper insights into why pre-commitment showed modest effectiveness in our study. Rather than simply overriding present bias through external constraints, pre-commitment strategies may work by triggering inferential processes about personal goals and their implementation (Van Dessel et al., 2022). When individuals are prompted to consider their future needs, this activates both immediate intuitions about financial control and competing intuitions about long-term security (De Neys, 2023). This aligns with emerging evidence that financial decision-making involves multiple simultaneous intuitive processes rather than a simple

conflict between intuitive and deliberative thinking (Voudouri et al., 2024). The small effect size we observed might therefore reflect that pre-commitment successfully activated long-term oriented intuitions about retirement security, but these had to compete with equally strong intuitions about maintaining financial flexibility and control. This interpretation is supported by research showing that commitment devices are most effective when they align with, rather than override, existing goals and preferences (Beshears et al., 2015; Rogers et al., 2014). In the context of pension decisions, where individuals face genuine uncertainty about future needs and circumstances, even activated long-term oriented intuitions may not be sufficient to overcome deeply held preferences for financial flexibility. This suggests that effective interventions might need to focus on reshaping how people think about the trade-off between security and control, rather than simply highlighting future needs.

Defaults

DS interventions (defaults), are well-known for their strong influence on behavior. According to a meta-analysis by Mertens et al. (2022), DS interventions typically show a notable effect size of $d = 0.33$ in the finance domain. Defaults, in particular, capitalize on status quo bias and inertia, guiding individuals toward pre-selected options with minimal cognitive effort (Samuelson & Zeckhauser, 1988). This behavioral intervention has been highly effective in retirement savings decisions (Madrian & Shea, 2001; Thaler & Benartzi, 2004). Here, we did not find a significant effect of defaults on annuitization decisions.

A critical consideration is whether our operationalization of "defaults" as starting positions on a continuous slider truly constitutes a default nudge in the traditional sense. Johnson & Goldstein's (2012) theoretical framework suggests that effective defaults operate through three key channels: endorsement (implicit recommendations from choice architects), ease (lower effort to maintain the default than to change it), and endowment (psychological ownership of the defaulted option). Our slider starting positions potentially failed to fully

engage these mechanisms. Participants may not have perceived the starting position as an endorsement or recommendation, but rather as an arbitrary starting point, whereas traditional defaults derive much of their power from being perceived as implicit recommendations (McKenzie et al., 2006; C. Sunstein, 2013; Tannenbaum, 2012). Furthermore, the interactive slider design made adjusting from the starting position just as easy as maintaining it, eliminating the effort asymmetry typical of powerful defaults (Carroll et al., 2009; Johnson & Goldstein, 2012).

Additionally, the immediate ability to adjust the slider may have prevented participants from developing any sense of endowment with the initial position, contrary to traditional defaults where status quo bias and loss aversion contribute to default adherence (Dinner et al., 2011; Kalkstein et al., 2022; Tversky & Kahneman, 1991). In fact, the interactive slider design may have encouraged active engagement and experimentation, the visual feedback of seeing how different allocations affected both monthly payments and lump sum amounts could have prompted participants to explore various options rather than accept the starting position. This dynamic interaction stands in stark contrast to traditional default implementations where the status quo option is more passive and static (Johnson & Goldstein, 2003). The engaging nature of sliders as an interface element has been shown to increase user interaction and adjustment in other decision contexts (Chapman et al., 2019; Matejka et al., 2016). Meta-analyses of default effects support this interpretation, showing that defaults are most effective when they create genuine friction against change and maintain a truly passive status quo option (Jachimowicz et al., 2019; Venema et al., 2020). Our interactive implementation may have thus transformed what was intended as a default nudge into more of an exploratory decision tool, fundamentally changing how participants approached the choice task.

Our interactive implementation may have thus transformed what was intended as a default nudge into more of an exploratory decision tool, fundamentally changing how participants approached the choice task. This transformation was likely amplified by the continuous nature of our dependent variable. While traditional binary defaults create clear decision boundaries that facilitate quick, intuitive choices (Thaler & Benartzi, 2004), continuous choice spaces require participants to consider multiple possible allocation points. This shift from a discrete to a continuous choice architecture may fundamentally alter how people process the decision task. Recent theoretical work on decision-making suggests that continuous choice spaces can trigger more elaborate information processing and comparison strategies compared to binary choices (De Neys, 2023; Voudouri et al., 2024).

Furthermore, by reframing the decision from a binary annuity vs. lump sum choice to a more flexible, adjustable option, our design may have altered how participants evaluated risk and uncertainty. Traditional binary annuitization decisions often trigger ambiguity aversion, pushing people toward the seemingly more concrete and immediate lump sum option (Brown et al., 2008b; Kahneman & Tversky, 1979). The continuous choice format, however, might have helped participants recognize that they weren't facing an all-or-nothing decision, potentially reducing the psychological barrier to considering partial annuitization. This interpretation aligns with research showing that breaking down complex financial decisions into smaller, more manageable choices can lead to more optimal decision-making (Benartzi & Thaler, 2013; Thaler & Benartzi, 2004).

However, since we did not directly compare binary and continuous choice architectures, these interpretations remain speculative. Future research should systematically investigate how different choice architectures - binary versus continuous - affect both the decision process and outcomes in pension distribution decisions. Such research could help

determine optimal ways to structure these important financial choices while maintaining decision-maker autonomy.

Social Norms and Evaluative Risk Labels

Despite the well-documented success of DI interventions, such as social norms and evaluative risk labels, in shaping behavior across a range of domains (Bateman et al., 2016; Festinger, 1954; Hummel & Maedche, 2019), our study found that these interventions had no significant impact on annuitization decisions. Social reference nudges, which have demonstrated a substantial impact on financial behaviors like retirement savings and stock market participation through peer influence and conformity bias (Banerjee & Das, 2023; Brown et al., 2008b; Duflo & Saez, 2003; Kubik et al., 2001), proved ineffective in the context of annuity choices. This observation may be attributed to the complex, individualized nature of retirement planning, where decisions are less susceptible to external social comparisons and more reliant on personal, intrinsic motivators (Brown, 2007).

Similarly, evaluative warning labels designed to simplify complex financial information and reduce cognitive load by engaging System 1 thinking (Bateman et al., 2016; Johnson et al., 2012; Thaler & Sunstein, 2008) did not influence annuity uptake in our study. Although such labels have been effective in other (financial) contexts by providing clear, accessible risk assessments (Bateman et al., 2016; Vlaev et al., 2009), they may not sufficiently address the cognitive biases and information-processing challenges inherent in annuitization decisions (Kahneman & Tversky, 1979; Lusardi & Mitchell, 2011). Recent developments in dual-process theory suggest that even seemingly intuitive decisions involve multiple competing intuitions rather than a simple deliberative override of biased intuitive responses (De Neys, 2023; Voudouri et al., 2024). In the context of annuitization, simplified risk labels may fail to engage with deeply ingrained intuitions about financial security and control that influence pension decisions. This aligns with emerging evidence that, unlike more

habitual consumer choices (e.g., energy efficiency or health), retirement planning decisions may be driven by sophisticated intuitive processes that integrate both immediate and long-term considerations, making them less susceptible to simple environmental cues (Van Dessel et al., 2022). Further research may be needed to refine how these interventions can be better contextualized for annuitization. Another potential explanation for our findings is that participants may have struggled to conceptualize the allocation of such a large sum of money (e.g., €100,000). Decision-making for large, abstract amounts may be more cognitively demanding than smaller, everyday financial decisions. This factor could have resulted in participants defaulting to familiar, simple choices (e.g., capital uptake or a round number split around 0 – 50 or 100% annuity) without fully engaging with the implications of annuitization. This cognitive challenge contrasts sharply with the approach in Thaler & Benartzi's (2004) *Save More Tomorrow* (SMarT) program, which targeted incremental increases in monthly payroll contributions rather than lump-sum allocations. Participants in the SMarT program only had to decide on small, periodic additions to their savings, typically from future pay raises. These manageable amounts, often tens of dollars rather than hundreds of thousands, allowed individuals to commit with minimal cognitive strain and without confronting the daunting concept of significant, one-time allocations. Future research could explore how framing the decision in terms of smaller, more relatable denominations affects annuity uptake, potentially mirroring the incremental design that proved successful in the SMarT program.

Nudge Combinations

The absence of significant interaction effects between decision assistance and decision structure or decision information interventions (RQ2 to RQ5) suggests that these strategies did not mutually reinforce each other in the ways anticipated. One potential explanation is that the cognitive load imposed by managing several complex interventions simultaneously could have diluted their effectiveness. When faced with complex decisions, individuals may

revert to simpler heuristics that override nuanced decision-making cues, as proposed by dual-system theory (Kahneman, 2011).

Recent theoretical developments offer a more nuanced explanation for this lack of interaction effects. Rather than simply overwhelming cognitive capacity, multiple simultaneous interventions may have created competing inferential processes that effectively neutralized each other (Van Dessel et al., 2022). Modern dual-process accounts suggest that decision-makers can simultaneously generate multiple sophisticated intuitions, even in complex scenarios (De Neys, 2021). In our case, different nudges may have activated distinct and potentially conflicting intuitions - for instance, social norms triggering conformity intuitions while evaluative labels activated risk-assessment intuitions. This interpretation aligns with emerging evidence that financial decisions involve parallel processing of multiple choice-relevant intuitions rather than a simple trade-off between heuristic and deliberative thinking (Voudouri et al., 2024). Under this framework, the absence of interaction effects may indicate that pension decisions require interventions that harmonize rather than layer different cognitive processes.

Overall, our findings suggest that while pre-commitment strategies show promise, other interventions, such as defaults, social norms, and evaluative labels, may need further refinement or may inherently lack effectiveness in influencing annuitization behavior within this specific context.

Consistent Decision Patterns

We observed a consistent decision pattern across all conditions: on average, 51.2% of participants opted for more than 95% capital uptake, 34.5% chose a mix, with a notable peak of 13% at exactly 50% annuity uptake, and 14.3% opted for less than 5% annuity. An overview of the observed frequencies of annuity choice in every condition is provided in Figure 2. This uniformity suggests that participants possess strong preferences that are

resistant to change through nudges alone. Research indicates that individuals often gravitate towards round numbers when making quantitative decisions, a phenomenon also known as "round number bias" (Pope & Simonsohn, 2011). The peaks at exactly 0%, 50%, and 100% annuity uptake suggest that participants favored these cognitively simpler, salient options, due to their cognitive accessibility (Gigerenzer & Gaissmaier, 2011; Hertwig & Grüne-Yanoff, 2017). These focal points may function as 'pre-existing defaults,' with 50% often perceived as a balanced allocation representing risk diversification (Muramatsu & Fonseca, 2012; Shah & Oppenheimer, 2008). By defaulting to these values, participants can avoid the cognitive effort of evaluating less prominent options. Moreover, this tendency may also stem from the participants' habitual exposure to binary decision-making frameworks commonly encountered in similar financial contexts. Traditional pension plans and retirement savings options often present choices in binary terms, such as full withdrawal or full annuitization, conditioning individuals to think within these familiar boundaries even when presented with more nuanced options (Agnew et al., 2008). This interpretation is supported by research on choice bracketing showing how prior experience with decision formats can create persistent mental models that influence future choices (Koch & Nafziger, 2016; Read et al., 1999). People may automatically parse continuous choice spaces into discrete categories based on these learned mental models, effectively creating their own implicit defaults at psychologically meaningful points like 0%, 50%, and 100 (Wakita et al., 2012). Future research could explore how such implicit anchors influence financial decision-making, even without formal defaults, and whether alternative choice architectures could help overcome these ingrained decision patterns.

While our initial explanations offer some insights into the observed decision patterns, it's important to situate our findings within the broader context of recent debates on the effectiveness of nudging interventions. Several meta-analyses and systematic reviews have

raised questions about the overall impact of nudges, suggesting that their effects may be smaller and less consistent than previously thought (Maier et al., 2022; Szaszi et al., 2022). In our study, many of the nudges we implemented did not produce the expected effects on annuity uptake decisions, despite being grounded in established behavioral theories and tested on a substantial sample size. This lack of significant outcomes highlights the potential limitations of nudging when applied to complex (financial) behaviors. Simultaneously, this observation suggests that while nudges can be effective in certain contexts, they may not suffice for influencing decisions that involve deeply rooted preferences or require a high level of deliberation.

Limitations

This study has several limitations that should be acknowledged. First, we employed a vignette-based design with hypothetical scenarios, which may not fully capture the complexities and emotional weight associated with real-world annuity decisions where actual financial stakes are involved. Implementing this type of experiment as a field study with real-life monetary consequences involves significant logistical and ethical complexities, making it challenging to replicate controlled conditions.

Second, while we used a continuous decision framework (sliders) to reflect the flexibility of annuitization options, this may have reduced the effectiveness of interventions like defaults, which are typically more impactful in binary decision contexts. Notably, we did not test the decision in a traditional binary format, limiting comparisons to real-world default effects.

Third, despite our efforts to create an ecologically valid testing environment with a large study sample ($N = 15,593$), the web-based nature of the study may have introduced sample biases, particularly in educational attainment. Our sample has a high proportion of participants with an Academic Bachelor (32.7%) or Professional Bachelor (29.8%), with only

26.0% having only Secondary Education. This overrepresentation of highly educated individuals, who may be expecting a larger pension and thus less inclined to feel like they should buy an annuity, may limit the generalizability of our findings. Notably, Thaler & Benartzi's (2004) *SMarT* program primarily targeted blue-collar workers, who might respond differently to such interventions.

Fourth, we did not consider reaction time when measuring participant decision-making. Reaction time can provide valuable insights into how confidently or automatically participants make their choices, particularly in complex financial decisions. Including this measure in future studies could help differentiate between thoughtful deliberation and quick, heuristic-based decisions.

Finally, the simplified nature of our experiment did not account for the real-world complexities of annuity decisions, such as tax implications or financial advice, which could influence participant behavior in practice.

Practical Implications

The implications for retirement policy are manifold. While most of the behavioral interventions didn't yield the expected effects in our study, our results indicate that, in contrast to real-world numbers, at least 50% of the population is at least partially open to annuitization, either in part or in full. This finding has important policy implications, as it suggests a substantial portion of individuals may be in the market for some form of annuity. Policymakers could focus on improving the framing and accessibility of annuity products to cater to this group, making them more attractive and easier to understand. As governments and financial institutions seek to encourage higher annuitization rates to mitigate longevity risks, our findings underscore the need for tailored interventions that address the specific cognitive and emotional barriers associated with retirement decisions. Pre-commitment

strategies, in particular, hold promise as a scalable solution to nudge individuals towards more optimal financial choices in retirement.

Conclusion

Our study highlights the challenges of influencing annuitization decisions through behavioral interventions. While pre-commitment strategies showed a small effect, other interventions did not yield the expected outcomes. Notably, the consistent decision patterns unaffected by nudging may not be attributed to statistical power issues, given the scale of this megastudy ($N = 15,593$). This observation suggests that individuals may rely on strong preferences and simple heuristics, which are to a large extent resistant to nudge interventions, when faced with complex financial decisions. Future efforts to address this resistance should focus on developing tailored approaches that more effectively address the cognitive and emotional factors influencing annuitization, thereby supporting individuals in making informed choices for their retirement security.

References

- Agnew, J. R., Anderson, L. R., Gerlach, J. R., & Szykman, L. R. (2008). Who Chooses Annuities? An Experimental Investigation of the Role of Gender, Framing, and Defaults. *American Economic Review*, 98(2), 418-422.
<https://doi.org/10.1257/aer.98.2.418>
- Antonio, K., Robben, J., & Devriendt, S. (2020). *The IA|BE 2020 mortality projection for the Belgian population*. <https://lirias.kuleuven.be/3363263&lang=en>
- Ashraf, N., Karlan, D. S., & Yin, W. (2006). *Household Decision Making and Savings Impacts: Further Evidence from a Commitment Savings Product in the Philippines* (SSRN Scholarly Paper No. 912771). <https://doi.org/10.2139/ssrn.912771>
- Bago, B., & De Neys, W. (2019). The intuitive greater good: Testing the corrective dual process model of moral cognition. *Journal of Experimental Psychology: General*, 148(10), 1782-1801. <https://doi.org/10.1037/xge0000533>
- Baláž, V. (2023). Indulgence, Self-Control, and Annuity Preferences: Annuity Choices by Members of the Slovak-Funded Private Pension Pillar. *Social Sciences*, 12(3), Article 3. <https://doi.org/10.3390/socsci12030190>
- Banerjee, P., & Das, T. (2023). *Peer Effects on Complex Financial Decisions* (SSRN Scholarly Paper No. 4557501). <https://doi.org/10.2139/ssrn.4557501>
- Bateman, H., Eckert, C., Geweke, J., Louviere, J., Satchell, S., & Thorp, S. (2016). Risk Presentation and Portfolio Choice. *Review of Finance*, 20(1), 201-229.
- Baumeister, R. F., Bratslavsky, E., Muraven, M., & Tice, D. M. (1998). Ego depletion: Is the active self a limited resource? *Journal of Personality and Social Psychology*, 74(5), 1252-1265. <https://doi.org/10.1037/0022-3514.74.5.1252>
- Bayar, Y. (2018). Financial Sustainability of Pension Systems in the European Union. *European Research Studies*, XVI(3), 46-70.

- Belgian Federal Pension Service. (2023). *Belgian statutory pension income statistics*. PensionStat.be. <https://www.pensionstat.be/nl/kerncijfers/wettelijk-pensioen/minimumpensioen>
- Benartzi, S., Beshears, J., Milkman, K. L., Sunstein, C. R., Thaler, R. H., Shankar, M., Tucker-Ray, W., Congdon, W. J., & Galing, S. (2017). Should Governments Invest More in Nudging? *PSYCHOLOGICAL SCIENCE*, 28(8), 1041-1055. <https://doi.org/10.1177/0956797617702501>
- Benartzi, S., Previtero, A., & Thaler, R. H. (2011). Annuitization Puzzles. *Journal of Economic Perspectives*, 25(4), 143-164. <https://doi.org/10.1257/jep.25.4.143>
- Benartzi, S., & Thaler, R. H. (2013). Behavioral Economics and the Retirement Savings Crisis. *SCIENCE*, 339(6124), 1152-1153. <https://doi.org/10.1126/science.1231320>
- Beshears, J., Choi, J. J., Harris, C., Laibson, D., Madrian, B. C., & Sakong, J. (2015). *Self Control and Commitment: Can Decreasing the Liquidity of a Savings Account Increase Deposits?* (Working Paper No. 21474). National Bureau of Economic Research. <https://doi.org/10.3386/w21474>
- Beshears, J., Choi, J. J., Laibson, D., Madrian, B. C., & Milkman, K. L. (2015). The Effect of Providing Peer Information on Retirement Savings Decisions. *The Journal of Finance*, 70(3), 1161-1201. <https://doi.org/10.1111/jofi.12258>
- Beshears, J., Choi, J. J., Laibson, D., Madrian, B. C., & Zeldes, S. P. (2014). What makes annuitization more appealing? *Journal of Public Economics*, 116, 2-16. <https://doi.org/10.1016/j.jpubeco.2013.05.007>
- Bielecki, M., Brzoza-Brzezina, M., & Kolasa, M. (2020). Demographics and the natural interest rate in the euro area. *European Economic Review*, 129, 103535. <https://doi.org/10.1016/j.euroecorev.2020.103535>

- Brown, J. R. (2007). Rational and Behavioral Perspectives on the Role of Annuities in Retirement Planning. *NBER Working Papers*, Article 13537.
<https://ideas.repec.org/p/nbr/nberwo/13537.html>
- Brown, J. R., Kling, J. R., Mullainathan, S., & Wrobel, M. V. (2008a). *Why Don't People Insure Late Life Consumption: A Framing Explanation of the Under-Annuitization Puzzle* (Working Paper No. 13748). National Bureau of Economic Research.
<https://doi.org/10.3386/w13748>
- Brown, J. R., Kling, J. R., Mullainathan, S., & Wrobel, M. V. (2008b). Why Don't People Insure Late-Life Consumption? A Framing Explanation of the Under-Annuitization Puzzle. *American Economic Review*, 98(2), 304-309.
<https://doi.org/10.1257/aer.98.2.304>
- Carroll, G. D., Choi, J. J., Laibson, D., Madrian, B. C., & Metrick, A. (2009). Optimal Defaults and Active Decisions*. *The Quarterly Journal of Economics*, 124(4), 1639-1674. <https://doi.org/10.1162/qjec.2009.124.4.1639>
- Chapman, L. E., Sadeghzadeh, C., Koutlas, M., Zimmer, C., & Marco, M. D. (2019). Evaluation of three behavioural economics 'nudges' on grocery and convenience store sales of promoted nutritious foods. *Public Health Nutrition*, 22(17), 3250-3260.
<https://doi.org/10.1017/S1368980019001794>
- Craig, J. (1994). Replacement level fertility and future population growth. *Population Trends*, 78, 20-22.
- Cronqvist, H., Thaler, R. H., & Yu, F. (2018). When Nudges Are Forever: Inertia in the Swedish Premium Pension Plan. *AEA Papers and Proceedings*, 108, 153-158.
<https://doi.org/10.1257/pandp.20181096>
- Dai, H., Saccardo, S., Han, M. A., Roh, L., Raja, N., Vangala, S., Modi, H., Pandya, S., Sloyan, M., & Croymans, D. M. (2021). Behavioural nudges increase COVID-19

- vaccinations. *Nature*, 597(7876), Article 7876. <https://doi.org/10.1038/s41586-021-03843-2>
- Dattani, S., Rodés-Guirao, L., Ritchie, H., Ortiz-Ospina, E., & Roser, M. (2023). Life Expectancy. *Our World in Data*. <https://ourworldindata.org/life-expectancy>
- Davidoff, T., Brown, J. R., & Diamond, P. A. (2005). Annuities and Individual Welfare. *American Economic Review*, 95(5), 1573-1590. <https://doi.org/10.1257/000282805775014281>
- De Neys, W. (2006). Dual processing in reasoning: Two systems but one reasoner. *Psychological Science*, 17(5), 428-433. <https://doi.org/10.1111/j.1467-9280.2006.01723.x>
- De Neys, W. (2021). On Dual- and Single-Process Models of Thinking. *Perspectives on Psychological Science*, 16(6), 1412-1427. <https://doi.org/10.1177/1745691620964172>
- De Neys, W. (2023). Further advancing fast-and-slow theorizing. *Behavioral and Brain Sciences*, 46, e146. <https://doi.org/10.1017/S0140525X23000559>
- DellaVigna, S., & Linos, E. (2022). RCTs to Scale: Comprehensive Evidence From Two Nudge Units. *Econometrica*, 90(1), 81-116. <https://doi.org/10.3982/ECTA18709>
- Dillingh, R., & Zumbuehl, M. (2021). Pension Payout Preferences. *CPB Discussion Paper*, Article 431. <https://ideas.repec.org/p/cpb/discus/431.html>
- Dinner, I., Johnson, E. J., Goldstein, D. G., & Liu, K. (2011). Partitioning default effects: Why people choose not to choose. *Journal of Experimental Psychology: Applied*, 17, 332-341. <https://doi.org/10.1037/a0024354>
- Donnellan, M. B., Oswald, F. L., Baird, B. M., & Lucas, R. E. (2006). The Mini-IPIP Scales: Tiny-yet-effective measures of the Big Five Factors of Personality. *Psychological Assessment*, 18(2), 192-203. <https://doi.org/10.1037/1040-3590.18.2.192>

- Duckworth, A. L., & Milkman, K. L. (2022). A guide to megastudies. *PNAS Nexus*, 1(5), pgac214. <https://doi.org/10.1093/pnasnexus/pgac214>
- Duflo, E., & Saez, E. (2003). The Role of Information and Social Interactions in Retirement Plan Decisions: Evidence from a Randomized Experiment*. *The Quarterly Journal of Economics*, 118(3), 815-842. <https://doi.org/10.1162/00335530360698432>
- Dushi, I., & Webb, A. (2004). Household annuitization decisions: Simulations and empirical analyses. *Journal of Pension Economics & Finance*, 3(2), 109-143. <https://doi.org/10.1017/S1474747204001696>
- Edwards, R. D. (2008). *The Cost of Uncertain Life Span* (Working Paper No. 14093). National Bureau of Economic Research. <https://doi.org/10.3386/w14093>
- Eurostat. (2024, februari). Fertility statistics 2022. *Eurostat World Data Statistics Explained*. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Fertility_statistics
- Festinger, L. (1954). *A Theory of Social Comparison Processes*. 7(2), 117-140.
- Finkelstein, A., & Poterba, J. (2004). Adverse Selection in Insurance Markets: Policyholder Evidence from the U.K. Annuity Market. *Journal of Political Economy*, 112(1), 183-208. <https://doi.org/10.1086/379936>
- Gigerenzer, G., & Gaissmaier, W. (2011). Heuristic Decision Making. *Annual Review of Psychology*, 62(Volume 62, 2011), 451-482. <https://doi.org/10.1146/annurev-psych-120709-145346>
- Goedde-Menke, M., Lehmensiek-Starke, M., & Nolte, S. (2014). An empirical test of competing hypotheses for the annuity puzzle. *Journal of Economic Psychology*, 43, 75-91. <https://doi.org/10.1016/j.joep.2014.04.001>
- Gollwitzer, P. M., & Sheeran, P. (2006). Implementation Intentions and Goal Achievement: A Meta-analysis of Effects and Processes. In *Advances in Experimental Social*

- Psychology* (Vol. 38, pp. 69-119). Academic Press. [https://doi.org/10.1016/S0065-2601\(06\)38002-1](https://doi.org/10.1016/S0065-2601(06)38002-1)
- Hertwig, R., & Grüne-Yanoff, T. (2017). Nudging and Boosting: Steering or Empowering Good Decisions. *Perspectives on Psychological Science*, 12(6), 973-986. <https://doi.org/10.1177/1745691617702496>
- Hummel, D., & Maedche, A. (2019). How effective is nudging? A quantitative review on the effect sizes and limits of empirical nudging studies. *Journal of Behavioral and Experimental Economics*, 80, 47-58. <https://doi.org/10.1016/j.socec.2019.03.005>
- Hurd, M. D., & McGarry, K. (1995). Evaluation of the Subjective Probabilities of Survival in the Health and Retirement Study. *The Journal of Human Resources*, 30, S268-S292. <https://doi.org/10.2307/146285>
- Hurwitz, A., Sade, O., & Winter, E. (2019). *Unintended Consequences of Minimum Annuity Laws: An Experimental Study* (SSRN Scholarly Paper No. 3117804). <https://doi.org/10.2139/ssrn.3117804>
- Inkmann, J., Michaelides, A., & Lopes, P. (2008). How Deep is the Annuity Market Participation Puzzle? *SSRN Electronic Journal*, 24. <https://doi.org/10.2139/ssrn.1099911>
- Ioannidis, J. P. A. (2005). Why Most Published Research Findings Are False. *PLOS Medicine*, 2(8), e124. <https://doi.org/10.1371/journal.pmed.0020124>
- Jachimowicz, J. M., Duncan, S., Weber, E. U., & Johnson, E. J. (2019). When and why defaults influence decisions: A meta-analysis of default effects. *Behavioural Public Policy*, 3(2), 159-186. <https://doi.org/10.1017/bpp.2018.43>
- Johnson, E. J., & Goldstein, D. (2003). Do Defaults Save Lives? *Science*, 302(5649), 1338-1339. <https://doi.org/10.1126/science.1091721>

Johnson, E. J., & Goldstein, D. G. (2012). *Decisions by Default* (SSRN Scholarly Paper No. 2173387). Social Science Research Network.

<https://papers.ssrn.com/abstract=2173387>

Johnson, E. J., Shu, S. B., Dellaert, B. G. C., Fox, C., Goldstein, D. G., Häubl, G., Larrick, R. P., Payne, J. W., Peters, E., Schkade, D., Wansink, B., & Weber, E. U. (2012). Beyond nudges: Tools of a choice architecture. *Marketing Letters*, 23(2), 487-504.

<https://doi.org/10.1007/s11002-012-9186-1>

Kahneman, D. (2011). *Thinking, fast and slow*. Farrar, Straus and Giroux.

Kahneman, D., & Tversky, A. (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica*, 47(2), 263-291. <https://doi.org/10.2307/1914185>

Kalkstein, D. A., Lima, F. D., Brady, S. T., Rozek, C. S., Johnson, E. J., & Walton, G. M.

(2022). Defaults are not a panacea: Distinguishing between default effects on choices and on outcomes. *Behavioural Public Policy*, 1-16.

<https://doi.org/10.1017/bpp.2022.24>

Koch, A. K., & Nafziger, J. (2016). Goals and bracketing under mental accounting. *Journal of Economic Theory*, 162, 305-351. <https://doi.org/10.1016/j.jet.2016.01.001>

Kubik, J. D., Hong, H. G., & Stein, J. C. (2001). *Social Interaction and Stock Market Participation* (SSRN Scholarly Paper No. 274077).

<https://doi.org/10.2139/ssrn.274077>

Laitin, D. D., Miguel, E., Alrababa'h, A., Bogdanoski, A., Grant, S., Hoeberling, K., Hyunjung Mo, C., Moore, D. A., Vazire, S., Weinstein, J., & Williamson, S. (2021). Reporting all results efficiently: A RARE proposal to open up the file drawer. *Proceedings of the National Academy of Sciences of the United States of America*, 118(52), e2106178118. <https://doi.org/10.1073/pnas.2106178118>

- Lockwood, L. M. (2012). Bequest motives and the annuity puzzle. *Review of Economic Dynamics*, 15(2), 226-243. <https://doi.org/10.1016/j.red.2011.03.001>
- Lusardi, A., & Mitchell, O. S. (2011). *Financial Literacy and Planning: Implications for Retirement Wellbeing* (Working Paper No. 17078). National Bureau of Economic Research. <https://doi.org/10.3386/w17078>
- Madrian, B. C., & Shea, D. F. (2001). The Power of Suggestion: Inertia in 401(k) Participation and Savings Behavior*. *The Quarterly Journal of Economics*, 116(4), 1149-1187. <https://doi.org/10.1162/003355301753265543>
- Maier, M., Bartoš, F., Stanley, T. D., Shanks, D. R., Harris, A. J. L., & Wagenmakers, E.-J. (2022). No evidence for nudging after adjusting for publication bias. *Proceedings of the National Academy of Sciences*, 119(31), e2200300119. <https://doi.org/10.1073/pnas.2200300119>
- Malhotra, N., & Simonovits, G. (2014). Social science. Publication bias in the social sciences: Unlocking the file drawer. *Science (New York, N.Y.)*, 345(6203), 1502-1505. <https://doi.org/10.1126/science.1255484>
- Matejka, J., Glueck, M., Grossman, T., & Fitzmaurice, G. (2016). The Effect of Visual Appearance on the Performance of Continuous Sliders and Visual Analogue Scales. *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, 5421-5432. <https://doi.org/10.1145/2858036.2858063>
- McKenzie, C. R. M., Liersch, M. J., & Finkelstein, S. R. (2006). Recommendations Implicit in Policy Defaults. *Psychological Science*, 17(5), 414-420. <https://doi.org/10.1111/j.1467-9280.2006.01721.x>
- Mertens, S., Herberz, M., Hahnel, U. J. J., & Brosch, T. (2022). The effectiveness of nudging: A meta-analysis of choice architecture interventions across behavioral domains.

- Proceedings of the National Academy of Sciences of the United States of America*, 119(1), e2107346118. <https://doi.org/10.1073/pnas.2107346118>
- Milevsky, M. A., & Young, V. R. (2007). The timing of annuitization: Investment dominance and mortality risk. *Insurance: Mathematics and Economics*, 40(1), 135-144. <https://doi.org/10.1016/j.insmatheco.2006.03.005>
- Milkman, K. L., Ellis, S. F., Gromet, D. M., Jung, Y., Luscher, A. S., Mobarak, R. S., Paxson, M. K., Silvera Zumaran, R. A., Kuan, R., Berman, R., Lewis, N. A., List, J. A., Patel, M. S., Van den Bulte, C., Volpp, K. G., Beauvais, M. V., Bellows, J. K., Marandola, C. A., & Duckworth, A. L. (2024). Megastudy shows that reminders boost vaccination but adding free rides does not. *Nature*, 1-10. <https://doi.org/10.1038/s41586-024-07591-x>
- Milkman, K. L., Gandhi, L., Patel, M. S., Graci, H. N., Gromet, D. M., Ho, H., Kay, J. S., Lee, T. W., Rothschild, J., Bogard, J. E., Brody, I., Chabris, C. F., Chang, E., Chapman, G. B., Dannals, J. E., Goldstein, N. J., Goren, A., Hershfield, H., Hirsch, A., ... Duckworth, A. L. (2022). A 680,000-person megastudy of nudges to encourage vaccination in pharmacies. *Proceedings of the National Academy of Sciences*, 119(6), e2115126119. <https://doi.org/10.1073/pnas.2115126119>
- Milkman, K. L., Gromet, D., Ho, H., Kay, J. S., Lee, T. W., Pandiloski, P., Park, Y., Rai, A., Bazerman, M., Beshears, J., Bonacorsi, L., Camerer, C., Chang, E., Chapman, G., Cialdini, R., Dai, H., Eskreis-Winkler, L., Fishbach, A., Gross, J. J., ... Duckworth, A. L. (2021). Megastudies improve the impact of applied behavioural science. *Nature*, 600(7889), 478-483. <https://doi.org/10.1038/s41586-021-04128-4>
- Mitchell, O. S., Poterba, J. M., Warshawsky, M. J., & Brown, J. R. (1999). New Evidence on the Money's Worth of Individual Annuities. *American Economic Review*, 89(5), 1299-1318. <https://doi.org/10.1257/aer.89.5.1299>

- Modigliani, F. (1986). Life Cycle, Individual Thrift, and the Wealth of Nations. *The American Economic Review*, 76(3), 297-313.
- Muramatsu, R., & Fonseca, P. (2012). Freedom of choice and bounded rationality A brief appraisal of behavioral economists plea for light paternalism. *Brazilian Journal of Political Economy*, 32(3), Article 3.
- O'Donoghue, T., & Rabin, M. (2015). Present Bias: Lessons Learned and to Be Learned. *American Economic Review*, 105(5), 273-279. <https://doi.org/10.1257/aer.p20151085>
- OECD. (2019). *Pensions at a Glance 2019: OECD and G20 Indicators*. Organisation for Economic Co-operation and Development. https://www.oecd-ilibrary.org/social-issues-migration-health/pensions-at-a-glance-2019_b6d3dcfc-en
- OECD. (2021). *Pensions at a glance 2021—Country profile Belgium*. <https://www.oecd.org/els/public-pensions/PAG2021-country-profile-Belgium.pdf>
- OECD. (2023). *Pensions at a Glance 2023*. <https://www.oecd-ilibrary.org/content/publication/678055dd-en>
- Open Science Collaboration. (2015). Estimating the reproducibility of psychological science. *Science*, 349(6251), aac4716. <https://doi.org/10.1126/science.aac4716>
- Pope, D., & Simonsohn, U. (2011). Round Numbers as Goals: Evidence From Baseball, SAT Takers, and the Lab. *Psychological Science*, 22(1), 71-79. <https://doi.org/10.1177/0956797610391098>
- Read, D., Loewenstein, G., & Rabin, M. (1999). Choice Bracketing. *Journal of Risk and Uncertainty*, 19(1), 171-197. <https://doi.org/10.1023/A:1007879411489>
- Rogers, T., Milkman, K. L., & Volpp, K. G. (2014). Commitment devices: Using initiatives to change behavior. *JAMA*, 311(20), 2065-2066. <https://doi.org/10.1001/jama.2014.3485>
- Rusconi, R. (2008). *National Annuity Markets*. <https://www.oecd-ilibrary.org/content/paper/240211858078>

- Samuelson, W., & Zeckhauser, R. (1988). Status quo bias in decision making. *Journal of Risk and Uncertainty*, 1(1), 7-59. <https://doi.org/10.1007/BF00055564>
- Shah, A. K., & Oppenheimer, D. M. (2008). Heuristics made easy: An effort-reduction framework. *Psychological Bulletin*, 134(2), 207-222. <https://doi.org/10.1037/0033-2909.134.2.207>
- Sinclair, S. H., & Smetters, K. A. (2004). Health Shocks and the Demand for Annuities: Technical Paper 2004-09. *Working Papers*, Article 15868. <https://ideas.repec.org/p/cbo/wpaper/15868.html>
- Soman, D., & Zhao, M. (2011). The Fewer the Better: Number of Goals and Savings Behavior. *Journal of Marketing Research*, 48(6), 944-957. <https://doi.org/10.1509/jmr.10.0250>
- Sunstein, C. (2013). Deciding by Default. *University of Pennsylvania Law Review*, 162(1), 1.
- Sunstein, C. R. (2014). *Nudging: A Very Short Guide* (SSRN Scholarly Paper No. 2499658). <https://doi.org/10.2139/ssrn.2499658>
- Szaszi, B., Higney, A., Charlton, A., Gelman, A., Ziano, I., Aczel, B., Goldstein, D. G., Yeager, D. S., & Tipton, E. (2022). No reason to expect large and consistent effects of nudge interventions. *Proceedings of the National Academy of Sciences*, 119(31), e2200732119. <https://doi.org/10.1073/pnas.2200732119>
- Tannenbaum, D. (2012). *Information Asymmetries in Default Options*. <https://www.chicagobooth.edu/~media/8205945153aa419a91fdaafaf546db24>
- Thaler, R. H., & Benartzi, S. (2004). Save More Tomorrow™: Using Behavioral Economics to Increase Employee Saving. *Journal of Political Economy*, 112(S1), S164-S187. <https://doi.org/10.1086/380085>
- Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decisions about health, wealth, and happiness* (pp. x, 293). Yale University Press.

- Tversky, A., & Kahneman, D. (1991). Loss Aversion in Riskless Choice: A Reference-Dependent Model. *The Quarterly Journal of Economics*, 106(4), 1039-1061.
<https://doi.org/10.2307/2937956>
- Van Dessel, P., Boddez, Y., & Hughes, S. (2022). Nudging societally relevant behavior by promoting cognitive inferences. *Scientific Reports*, 12(1), Article 1.
<https://doi.org/10.1038/s41598-022-12964-1>
- Venema, T. A. G., Kroese, F. M., Benjamins, J. S., & de Ridder, D. T. D. (2020). When in Doubt, Follow the Crowd? Responsiveness to Social Proof Nudges in the Absence of Clear Preferences. *Frontiers in Psychology*, 11.
<https://doi.org/10.3389/fpsyg.2020.01385>
- Vlaev, I., Chater, N., & Stewart, N. (2009). Dimensionality of Risk Perception: Factors Affecting Consumer Understanding and Evaluation of Financial Risk. *Journal of Behavioral Finance*, 10(3), 158-181. <https://doi.org/10.1080/15427560903167720>
- Voudouri, A., Białek, M., & De Neys, W. (2024). Fast & slow decisions under risk: Intuition rather than deliberation drives advantageous choices. *Cognition*, 250, 105837.
<https://doi.org/10.1016/j.cognition.2024.105837>
- Wakita, T., Ueshima, N., & Noguchi, H. (2012). Psychological Distance Between Categories in the Likert Scale: Comparing Different Numbers of Options. *Educational and Psychological Measurement*, 72(4), 533-546.
<https://doi.org/10.1177/0013164411431162>
- Wettstein, G., Munnell, A. H., Hou, W., & Gok, N. (2021). *The Value of Annuities* (SSRN Scholarly Paper No. 3797822). <https://doi.org/10.2139/ssrn.3797822>
- Wu, S., Stevens, R., & Thorp, S. (2015). Cohort and target age effects on subjective survival probabilities: Implications for models of the retirement phase. *Journal of Economic Dynamics and Control*, 55(C), 39-56.

Yaari, M. E. (1965). Uncertain Lifetime, Life Insurance, and the Theory of the Consumer.

The Review of Economic Studies, 32(2), 137-150.

Supplementary Information

Table S1

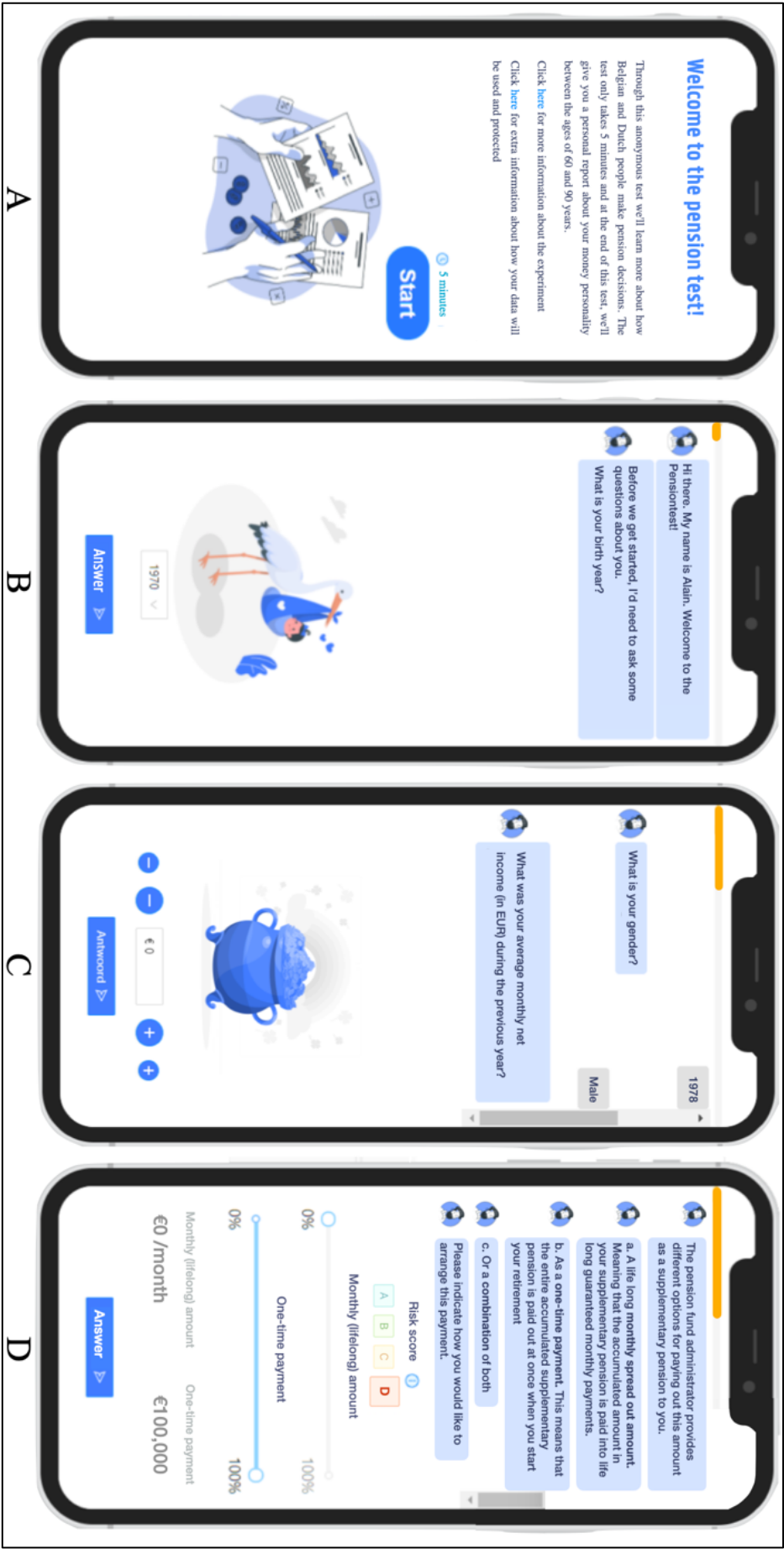
Study conditions overview

Condition	Default (DS)	Pre-commitment (DA)	Social norms (DI)	Evaluative risk labels (DI)	<i>n</i>
1	100-0	No	No	No	614
2	100-0	No	Yes	No	274
3	100-0	No	No	Yes	586
4	100-0	No	Yes	Yes	289
5	50-50	No	No	No	618
6	50-50	No	Yes	No	248
7	50-50	No	No	Yes	639
8	50-50	No	Yes	Yes	259
9	0-100	No	No	No	625
10	0-100	No	Yes	No	274
11	0-100	No	No	Yes	623
12	0-100	No	Yes	Yes	275
13	100-0	Yes	No	No	1,153
14	100-0	Yes	Yes	No	557
15	100-0	Yes	No	Yes	1,134
16	100-0	Yes	Yes	Yes	551
17	50-50	Yes	No	No	1,226
18	50-50	Yes	Yes	No	576
19	50-50	Yes	No	Yes	1,166
20	50-50	Yes	Yes	Yes	543
21	0-100	Yes	No	No	1,151
22	0-100	Yes	Yes	No	496
23	0-100	Yes	No	Yes	1,174
24	0-100	Yes	Yes	Yes	542

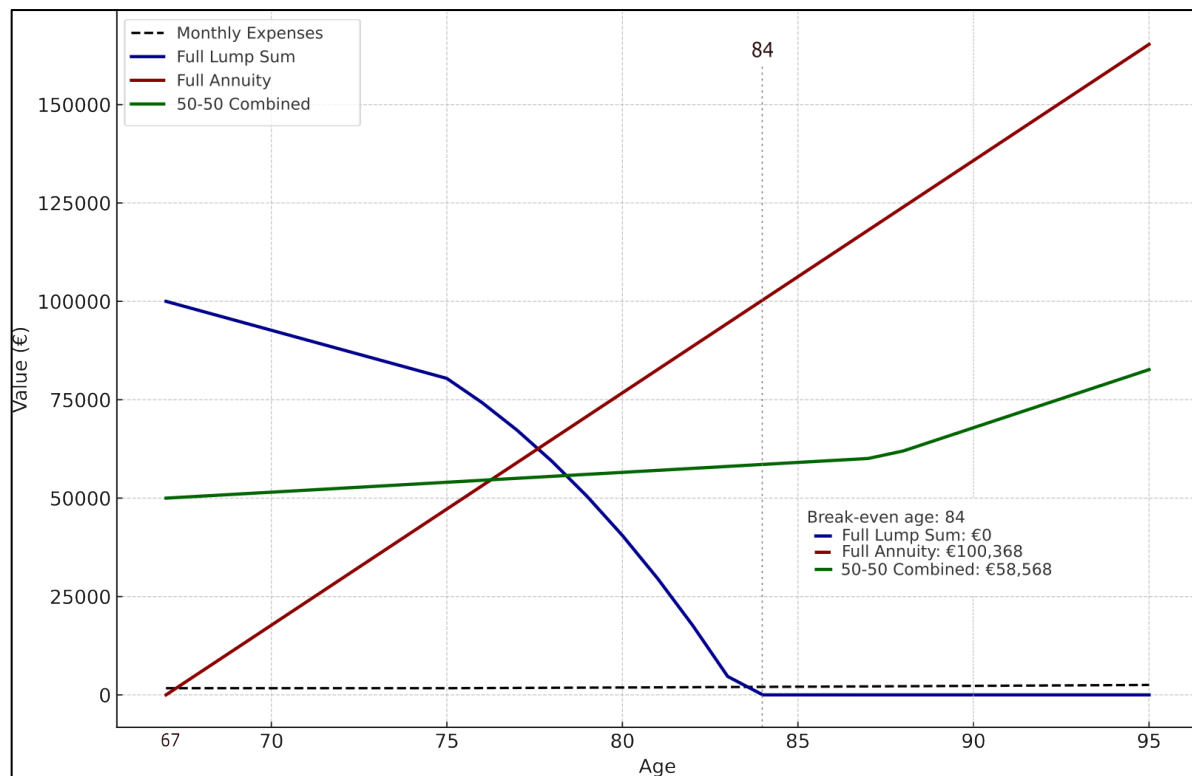
Note. The table represents our 3x2x2x2 experimental design where participants were assigned to one of 24 combinations of default settings, pre-commitment, social norms and evaluative risk labels. The sample size for each condition is provided.

Figure S1

Study conditions overview



Note. The chatbot interface design (Dutch original translated to English for clarity) showing: (A) Welcome screen with study information, (B) Initial demographic questions with chatbot introduction, (C) Income assessment screen, and (D) Example pension distribution decision interface with evaluative risk score visualization and dual slider system.

Figure S2*Simulated Wealth Trajectories Under Different Pension Distribution Choices*

Note. The graph compares three simulated pension distribution strategies starting at age 67, with monthly expenses increasing by 2% annually after age 75 to reflect higher healthcare and assistance needs. Initial conditions: €1,500 state pension, €1,704 monthly expenses during retirement. At the break-even age of 84, the full annuity (€492/month) has accumulated €100K, while the 50-50 split strategy (€50,000 + €246/month) shows a total value of €59K, and the remaining lump sum has decreased to €0K.

Figure S3

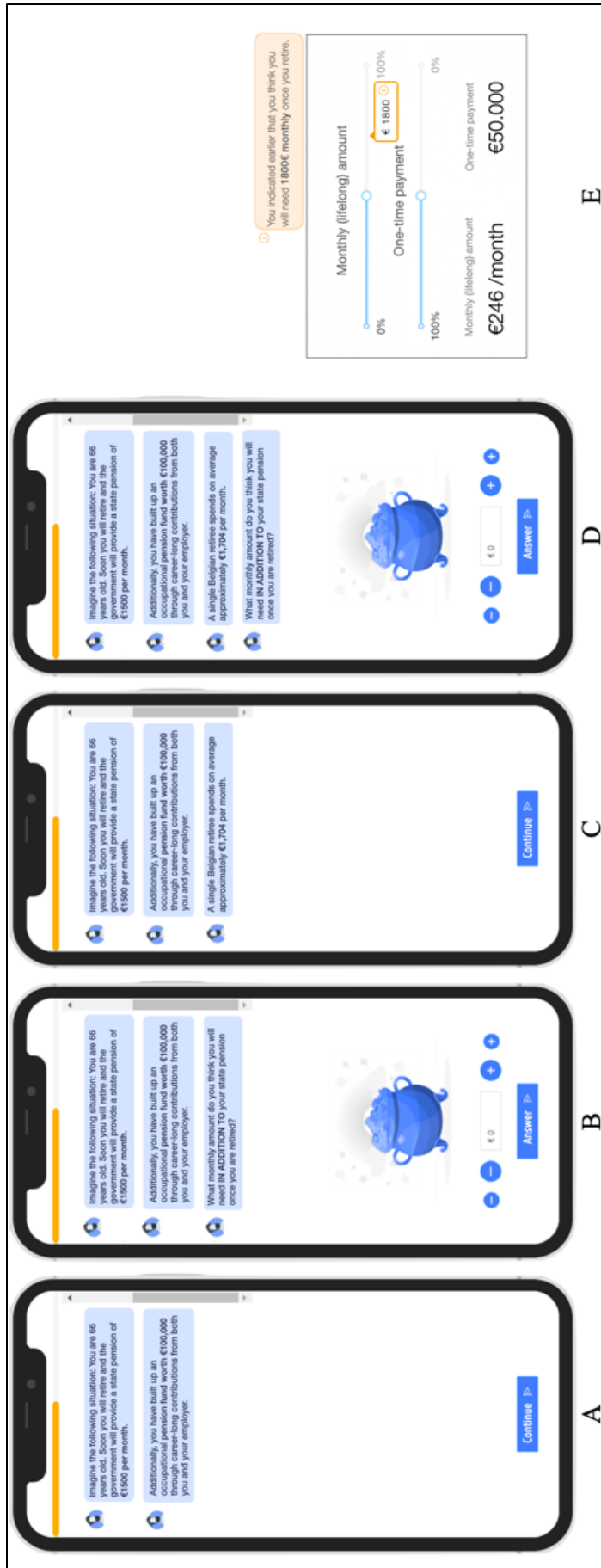
Default Settings (DS) Implementation Showing Three Initial Slider Positions



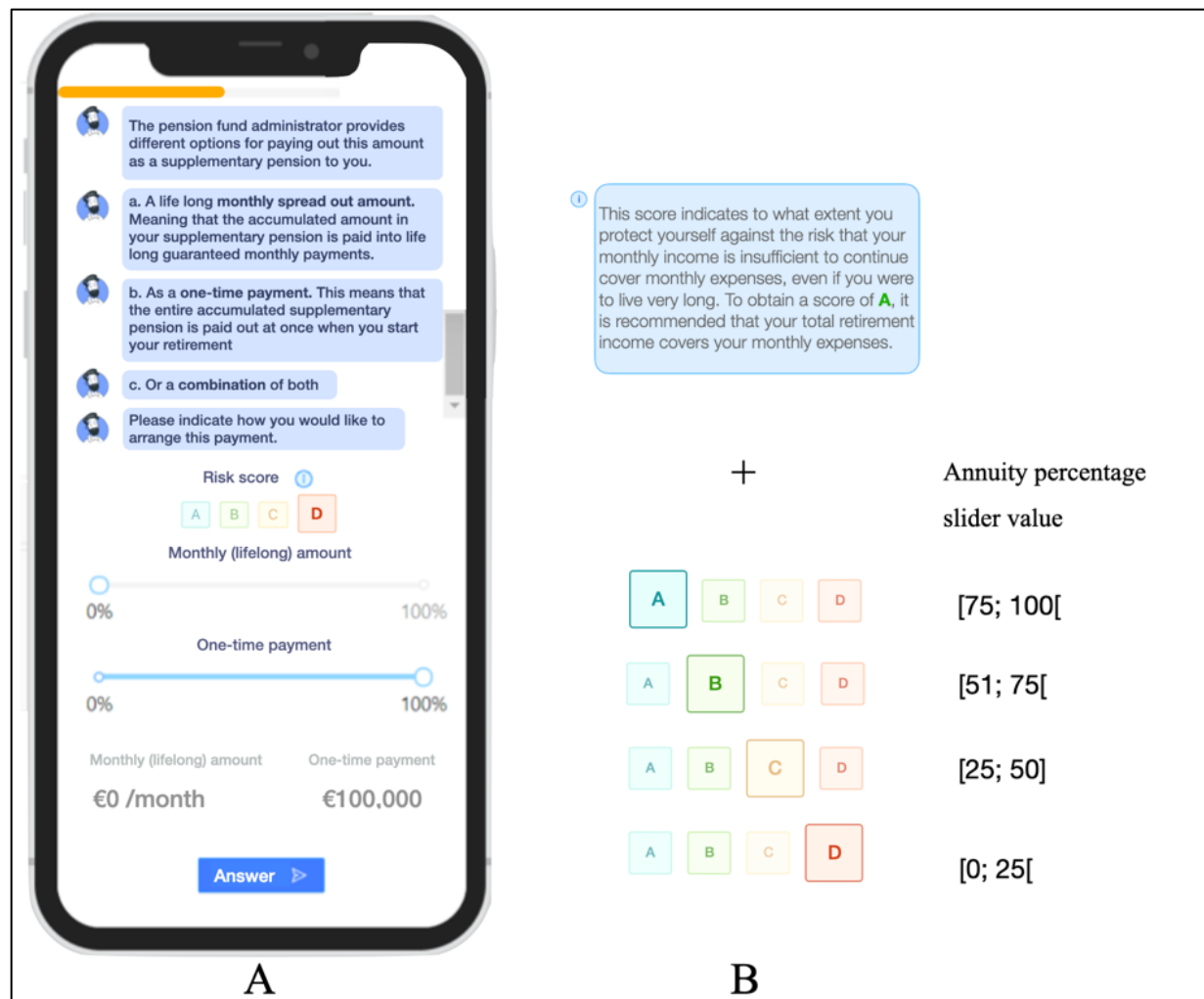
Note. Implementation of the three default settings showing initial slider positions and corresponding monetary outcomes: balanced (50-50), full annuitization (100-0), and full lump sum (0-100). First number in each pair represents percentage allocated to lifelong monthly payments (annuity).

Figure S4

Implementation of Pre-commitment (DA) and Social Norms (DI) Manipulations



Note. Sequential interface showing all possible manipulation combinations: (A) Basic control condition showing only the retirement scenario (€1,500 state pension and €100,000 occupational pension fund), seen by participants who received neither pre-commitment nor social norm interventions; (B) Pre-commitment only condition, where participants indicate their desired additional monthly retirement income using a numeric input field with +/- adjustments; (C) Social norm only condition, informing participants that an average single Belgian retiree spends €1,704 monthly; (D) Combined condition showing both the social norm information and pre-commitment prompt; and (E) Example of the decision interface showing the 50-50 default position (€246/month and €50,000 lump sum). Regardless of the default setting (0-100, 50-50, or 100-0), participants who received a pre-commitment intervention saw their indicated monthly need displayed in an orange tooltip with a visual pointer (shown example: €1,800). For amounts exceeding the maximum possible displayable monthly income of €1,992 (€1,500 state pension + €492 maximum annuity), the reminder was adjusted to acknowledge this excess (e.g., "You indicated earlier that you think you will need more than 1992€ monthly once you retire").

Figure S5*Implementation of the Evaluative Risk Labels (DI) in the Decision Interface*

Note. Panel A shows the decision interface with evaluative risk labels, featuring (1) a color-coded risk score system ranging from A (green) to D (red), (2) an information icon that, when clicked, explains how the score indicates protection against longevity risk, and (3) the dual-slider system for allocation decisions. Panel B illustrates how the risk scores dynamically updated based on annuitization percentages: scores of A (green) for 75-100% annuitization, B (light green) for 51-75%, C (orange) for 25-50%, and D (red) for 0-25%. The risk labels provided real-time feedback as participants adjusted their allocation between monthly payments and lump sum, with higher annuitization levels resulting in better risk scores reflecting greater protection against longevity risk.

Table S2*Descriptives Non-Categorical Individual Characteristics*

	<i>M</i>	<i>SD</i>	Min.	Max.	Cronbach's <i>a</i>	<i>n</i> _{items}
Age	50	11	18	66		
Life Expectancy	5.4	1.1	1.0	7.0		
Neuroticism	4.8	1.2	1.5	7.0	.61	2
Extraversion	4.0	1.2	0.7	6.7	.73	3
Openness	4.1	1.1	0.3	6.3	.70	4
Agreeableness	5.1	1.0	1.0	7.0	.71	4
Conscientiousness	4.5	1.1	0.5	6.5	.71	4
Self-Control	3.5	0.8	1.0	7.0	.67	5
Financial Self-Efficacy	2.8	1.1	1.0	7.0	.78	6
Financial Literacy	2.6	0.7	0.0	3.0	.44	3

Note. **Life expectancy:** 7-point likelihood scale of reaching age 85 (Hurd & McGarry, 1995).

Personality traits measured via Dutch Mini-IPIP (Donnellan et al., 2006), 7-point scale, with items like "I sympathize with others' feelings" (Agreeableness), "I get chores done right away" (Conscientiousness), "I don't talk much" (Extraversion), and "I'm not interested in abstract ideas" (Openness). **Self-Control** (Tangney et al., 2004): "I find it difficult to break bad habits"; **Financial Self-Efficacy** (Lown, 2011): "I lack confidence in my ability to manage my finances"; both 7-point scales. **Financial Literacy** used Lusardi's (2011) BIG 3 with multiple choice items like "If you have €100 in a savings account with 2% annual interest, how much would you have after five years?"

Table S3*Categorical Individual Characteristics*

	<i>n</i>	%
Sex		
Female	6,680	42.8
Male	8,913	57.2
Marital Status		
Single/Not Married	2,646	17.0
Cohabiting	1,468	9.4
Legal Cohabiting	1,799	11.5
Married	8,360	53.6
Divorced	1,141	7.3
Widow(er)	179	1.1
Salary		
< 2000	6,279	40.3
2000	3,577	22.9
> 2000	5,737	36.8
Highest Educational Degree		
Secondary Education	4,059	26.0
Professional Bachelor	4,653	29.8
Academic Bachelor	779	5.0
Academic Master	5,097	32.7
PhD	592	3.8
None	413	2.6
Employment Status		
Unemployed	457	2.9
Governmental Official	2,622	16.8
Laborer	909	5.8
Employee	6,706	43.0
Self-Employed	4,562	29.3
Self-Employed in Secondary Occupation	337	2.2

Note. Salary is expressed in net income (in euros) per month.

6

Discussion

The profound demographic transformation of the 21st century presents an unprecedented challenge to retirement security (Miles, 2023; Van Bavel, 2013). As life expectancy continues to rise while fertility rates decline, pension systems worldwide face mounting pressure to adapt (OECD, 2023; Vandresse, 2021). Through four empirical studies involving over 18,000 participants, this PhD dissertation examined how behavioral science can improve pension decisions across the life cycle. The current PhD dissertation, embedded within a broader Strategic Basic Research (SBO) project titled 'Towards Efficient Pillar II and III Pension Decisions in Belgium', addresses several critical gaps in our understanding: **(1)** the lack of systematic comparisons between distinct types of interventions (DS/DA/DI) within European (EU) welfare systems, **(2)** the narrow focus on binary outcomes, such as enrollment decisions, rather than the influence of interventions on contribution levels, **(3)** the unexplored synergies or interference effects when combining different types of interventions (DS/DA/DI), **(4)** the limited applicability of findings from U.S. settings to European welfare systems with their unique institutional and social contexts, and **(5)** the insufficient exploration of nuanced cognitive mechanisms beyond traditional dual-process theories in understanding how interventions affect pension decisions.

Using Modigliani's (1986) Life-Cycle Hypothesis as a framework, we systematically identified and investigated four impactful financial decisions at critical junctures during the life-cycle where behavioral barriers significantly impact long-term retirement security. While traditional economic theory posits that individuals rationally smooth consumption throughout their lifespan (Ando & Modigliani, 1963), our behavioral economics lens reveals significant deviations from these economic predictions (Benartzi & Thaler, 2013; O'Donoghue & Rabin, 2015). Following Mertens et al.'s (2022) comprehensive framework, we examined all three distinct categories of behavioral interventions (and several combinations of interventions): decision structure (DS) interventions that alter choice architecture, decision assistance (DA)

interventions that aid follow-through, and decision information (DI) interventions that modify information presentation.

Our findings reveal both the promise and limitations of behavioral interventions across the life cycle. While some nudges proved remarkably effective in specific contexts, their impact varied considerably across life stages and decision environments. Several consistent patterns emerged: First, defaults are often considered a reliable tool to steer decision-making; however, their effectiveness varied substantially depending on the choice architecture. While default effects worked as expected for binary decisions (Chapter 4), these mechanisms failed to influence continuous allocation choices (Chapter 5). Second, interventions involving smaller monetary amounts and incremental decisions (like investing spare change in Chapter 2 or daily-framed contributions in Chapter 3) showed greater effectiveness than those involving large lump sums (like the €100,000 pension allocation in Chapter 5). Third, and related to our previous finding; intervention effectiveness typically declined as the psychological distance of decisions increased. For example, framing retirement contributions in daily terms (Chapter 3) proved more effective than addressing distant outcomes like decumulation strategies (Chapter 5). Fourth, our findings within the Belgian pension context suggest that behavioral interventions may operate differently in strong welfare state environments than previously documented in U.S.-based research, though direct comparative studies would be needed to confirm this observation.

The following discussion examines these patterns in detail, exploring how different behavioral interventions perform across the life cycle and what this means for both theory and practice.

Not All Defaults Are Equal

One of our most striking findings challenges the conventional wisdom about default nudge effectiveness in retirement decisions. While defaults have been widely celebrated as a powerful tool for improving retirement outcomes (Jachimowicz et al., 2019; Madrian & Shea, 2001; Thaler & Benartzi, 2004), across our studies, if we observed an effect, it was substantially smaller than those typically reported in U.S.-based research or meta-analytical work (Jachimowicz et al., 2019). Our results reveal that their effectiveness varies substantially depending on how choices are structured, the decision context and complexity. These findings align with recent debate among scholars questioning the universal effectiveness of nudging interventions (Maier et al., 2022; Szaszi et al., 2022). However, rather than indicating default nudges don't work, our results suggest their impact depends heavily on institutional context and implementation details, a nuance emerging as central to understanding when and why nudges succeed or fall short (DellaVigna & Linos, 2022).

For example, in simple, binary decisions, defaults showed significant but modest effectiveness. Our occupational pension study (Chapter 4) found that opt-out defaults increased enrollment rates by 8.5 percentage points (72.6% vs. 64.1%), corresponding to a Cohen's $d = 0.21$. While significant, this effect is substantially smaller than those typically reported in U.S.-based studies, where enrollment differences often exceed 40 percentage points (Madrian & Shea, 2001). Meta-analyses of default effects correspondingly report much larger average effect sizes of $d = 0.68$ (Jachimowicz et al., 2019). Similarly, in our early-life spare-change investment study (Chapter 2), "set-and-forget" defaults promoted saving behavior, but with more modest effects than those observed in comparable U.S. settings.

This attenuated default effectiveness, even in straightforward binary choices, suggests important limitations to generalizing U.S.-based findings to other contexts. The reduced magnitude of default effects might reflect differences in institutional environments,

administrative processes, or decision-making contexts. For instance, the substantial administrative friction in our occupational pension study (Chapter 4), requiring appointments for both opting in and out, may have encouraged more deliberative processing, thereby reducing default nudge power.

However, default effectiveness surprisingly disappeared when choices became more complex. In our annuitization mega-study (Chapter 5), default settings showed no significant impact when participants faced continuous allocation decisions. This stark contrast suggests that choice architecture fundamentally moderates default power. The finding extends recent theoretical work on choice complexity (Szasz et al., 2022) and raises important questions about when defaults can effectively influence behavior.

We propose several interrelated mechanisms to explain this contextual variation in default effectiveness, building on recent theoretical developments in cognitive science and decision-making research. First, while traditional dual-process accounts suggest decision complexity shifts processing from System 1's automatic responses to System 2's deliberative thinking (Kahneman, 2011), recent evidence indicates a more nuanced reality. Rather than triggering purely analytical processing, complex decisions may activate multiple competing intuitions that operate simultaneously (De Neys, 2023; Voudouri et al., 2024). This helps explain why continuous allocation decisions reduce default effectiveness compared to binary choices, they engage different types of intuitive processing rather than necessarily prompting more deliberation.

Second, participants appeared more resistant to nudges when decisions involved larger sums of money and more complex tradeoffs. When facing decisions about substantial pension assets (€100,000 in Chapter 5), they showed greater resistance to default influences compared to smaller, incremental decisions like micro-investing spare change (Chapter 2) or monthly contribution choices (Chapter 3). However, rather than simply triggering more System 2

thinking as traditionally assumed (Kahneman, 2011), high stakes may increase emotional engagement (Loewenstein & Lerner, 2003), interact with psychological distance (Trope & Liberman, 2010), and activate different mental accounting principles (Thaler, 1999). This aligns with emerging research showing that behavioral interventions are markedly more potent when targeting small, recurring financial decisions compared to one-time, high-stakes choices about significant portions of wealth (Kalkstein et al., 2022; Koch et al., 2024). Third, administrative friction potentially interacts with complexity in unexpected ways. While some friction enhanced default effectiveness in simple decisions (Chapter 4), possibly by discouraging opt-out, excessive complexity combined with friction may push individuals toward more deliberative (System 2) decision-making that reduces default power.

Third, administrative friction appears to interact with complexity through multiple mechanisms beyond just encouraging deliberation. While some friction enhanced default effectiveness in simple decisions (Chapter 4), possibly by serving as an attentional cue signaling decision importance, excessive complexity combined with friction may affect motivation and cognitive resource allocation in unexpected ways. This can be understood through an inferential processing framework (Van Dessel et al., 2022) where contextual factors like complexity and friction influence what inferences people draw about decision goals, available actions, and the match between them. The effectiveness of defaults thus likely depends on how these factors interact with goal activation, perceived feasibility, and motivational conflicts (Kruglanski et al., 2015), moderated by individual differences in domain expertise, processing tendencies, and risk preferences (Peters et al., 2019). This more sophisticated theoretical understanding suggests the need to move beyond simple dual-process accounts toward models that capture how contextual factors simultaneously affect multiple aspects of processing. Such insights can inform the design of more effective, context-sensitive interventions that work with rather than against natural decision-making processes.

These findings have important implications for pension policy design. They suggest that defaults may be most effective when targeting simple, early-life decisions or when complex choices can be restructured into simpler ones. This aligns with research showing how choice architecture can reduce cognitive load (Johnson et al., 2012) and extends understanding of default boundary conditions in retirement decisions (Carroll et al., 2009).

Psychological Distance

A second key pattern emerging from our research reveals how psychological distance (the perceived temporal, social, and experiential gap between the present self and future retirement needs), systematically moderates the effectiveness of behavioral interventions in pension decisions. This finding extends two important theoretical frameworks. First, construal level theory suggests that psychological distance influences how abstractly or concretely people think about decisions (Trope & Liberman, 2010). Second, temporal discounting research examines how people systematically undervalue future rewards compared to immediate ones (Laibson, 1997). Together, these perspectives offer new insights into when and why different nudges succeed or fail in retirement planning.

Our temporal reframing study (Chapter 3) provided the clearest demonstration of this observed pattern. Daily framing of contributions led to significantly higher projected monthly savings (€106.87) compared to weekly (€84.28) or monthly frames (€91.15). Taking into account the principle of compounding interests, this substantial difference, when invested over a long time horizon, has the potential to compound in a substantial additional retirement buffer, that have the power to cascade into markedly different retirement outcomes. This finding extends Gourville, (1998) "pennies-a-day" effect into retirement decisions while supporting Thaler's (1985) mental accounting theory on how temporal frames influence financial choices.

However, psychological distance effects manifested differently across the life cycle. In early adulthood, when decisions involved smaller, more immediate amounts, behavioral interventions showed robust effectiveness. The success of "set-and-forget" defaults in promoting spare change micro-investing (Chapter 2) demonstrates how reduced psychological distance can facilitate adoption of beneficial financial behaviors. This aligns with research showing that immediate, concrete decisions engage more automatic processing (Kahneman, 2011) and face fewer behavioral barriers. As decisions became more psychologically distant and abstract, intervention effectiveness declined markedly. This pattern emerged in our occupational pension study (Chapter 4), where even successful default effects required substantial administrative engagement. The trend culminated in our decumulation annuity take-up mega-study (Chapter 5), where participants showed strong resistance to both social and numerical anchors when making complex decisions about distant retirement scenarios. This declining effectiveness suggests that psychological distance may fundamentally alter how individuals process and respond to behavioral interventions.

We identify three mechanisms through which psychological distance appears to influence intervention effectiveness. First, temporal distance shapes how people perceive decisions: near-term choices are processed with a focus on specific, tangible details, while distant decisions are considered more abstractly (Trope & Liberman, 2010). This explains why daily frames outperformed monthly ones: they made saving feel more tangible and actionable. Second, psychological distance interacts with cognitive load, with distant decisions requiring more deliberative processing that can override nudge effects (Kahneman, 2011). Third, the magnitude of consequences appears to amplify distance effects, with larger sums triggering more analytical thinking that resists behavioral influence. This observation is supported by evidence from Pennycook et al. (2015), highlighting that individuals engaging in more analytic reasoning are less likely to rely on intuitive responses and are more resistant to

influences that leverage emotional or heuristic decision-making. This tendency can influence how they respond to decisions with larger stakes, requiring more deliberate processing.

These insights have important implications for designing pension interventions across the life cycle. They suggest that behavioral strategies may be most effective when they can reduce psychological distance or when distant decisions can be reframed into more immediate ones. This aligns with emerging research on temporal landmarks in financial decision-making (Dai et al., 2014) and extends our understanding of how psychological distance shapes retirement planning.

Social Influence

A third significant pattern emerging across our studies is the limited and sometimes counterintuitive effect of social influence interventions in financial decision-making across the life-cycle in a European context. Across all four studies, social norm interventions showed surprisingly limited impact. In early adulthood, dynamic peer norms failed to boost round-up investing enrollment (Chapter 2). More strikingly, social reference points suppressed saving amounts in contribution decisions (Chapter 3), while trending norms showed no effect on pension enrollment despite high administrative friction (Chapter 4). This pattern culminated in our decumulation mega-study (Chapter 5), where social anchors consistently failed to influence annuitization choices.

This pattern is particularly noteworthy given meta-analytical evidence showing social reference interventions' general effectiveness ($d = 0.34$) across behavioral domains (Mertens et al., 2022). Our findings align with recent evidence from other researchers who found similar limitations of social influence in financial settings (Beshears et al., 2015; Duflo & Saez, 2002). Several mechanisms may explain this unexpected resistance to social influence in pension decisions, particularly within European contexts.

First, the strong welfare state context appears to fundamentally alter how individuals process social information about retirement planning. Unlike in the U.S., where peer behavior may signal crucial survival strategies in a weaker social safety net (Mitchell & Lusardi, 2011), European citizens may feel less compelled to conform to peer financial behaviors due to stronger baseline security (Anderson, 2015; Castellino et al., 2020). This institutional difference may explain why Beshears et al. (2015) found peer information slightly decreased savings rates among low-saving employees, while Dur et al. (2021) found social norm nudges ineffective in increasing savings at a retail bank.

Second, the private nature of financial decisions in digital environments may reduce the salience of social influences. While traditional research on social norms often examined visible behaviors (Cialdini & Trost, 1998), modern pension decisions occur even more in isolation through digital interfaces. This privacy may diminish the power of conformity bias, particularly when combined with the complex, long-term nature of retirement planning (Raue et al., 2020).

Third, we observe what we term a "credibility threshold effect": social norm interventions appear to lose power when the referenced peer behavior seems either unattainable or irrelevant to the decision-maker. This extends recent work on source credibility in behavioral interventions (de Ridder et al., 2022) and suggests that social influences may require careful calibration to maintain effectiveness. Additionally, psychological reactance may emerge when individuals perceive social influence attempts in highly personal financial matters (Dur et al., 2021)

These findings have important implications for the transfer of behavioral interventions across institutional contexts. While social norm techniques have proven valuable in many U.S. financial decisions (Beshears et al., 2015), their effectiveness may not translate directly

to European welfare states. This challenges the assumption of universal applicability in behavioral economics and suggests a need for more contextualized intervention design.

For policy makers and pension administrators, these results indicate that social comparison strategies may need significant adaptation for European contexts. Rather than relying on peer behavior as a primary motivator, interventions might be more effective when focused on individual goals and needs, particularly in strong welfare state environments. This aligns with emerging research on personalization in behavioral interventions (Li et al., 2024; Mills, 2022; Peer et al., 2020) and suggests promising directions for future investigation.

The Complexity-Engagement Paradox

A fourth intriguing pattern emerging from our research reveals a paradox in how decision complexity influences behavioral intervention effectiveness. While traditional choice architecture often seeks to simplify decisions (Thaler & Sunstein, 2008), our findings suggest that increased complexity can sometimes trigger more engaged decision-making, particularly when involving substantial financial stakes.

This complexity-engagement dynamic manifested most clearly in our annuitization mega-study (Chapter 5). When presented with a continuous choice scale rather than a binary decision, participants demonstrated distinct clustering around salient round number reference points (0%, 50%, and 100% annuitization). Specifically, 51.2% opted for nearly full capital uptake, 13% chose exactly 50% annuitization, and 14.3% selected full annuitization. This "round number bias" suggests that when facing complex decisions, individuals create their own simplified choice architecture through cognitive shortcuts (Pope & Simonsohn, 2011).

The pattern of intervention effectiveness across decision complexity offers several insights. In simpler decisions, such as round-up investing enrollment (Chapter 2) or binary pension participation (Chapter 4), behavioral interventions showed predictable effects aligned with previous research (Madrian & Shea, 2001). However, as decision complexity increased,

particularly in scenarios involving larger sums or more sophisticated trade-offs, traditional nudges lost power while evidence of more deliberative processing emerged.

We propose three mechanisms to explain this complexity-engagement relationship:

Stake-Driven Engagement

When decisions involve substantial financial consequences, as in our annuitization study, individuals appear more likely to override System 1's automatic responses in favor of more deliberative processing (Kahneman, 2011). This explains why nudges that typically leverage automatic processing showed diminished effectiveness in high-stakes scenarios. These findings are consistent with prior research that highlights a shift to System 2 engagement when the stakes are high or the complexity of the decision increases. For instance, studies have shown that in tactical decision-making tasks, experts benefit significantly from additional deliberation, achieving superior outcomes compared to those relying solely on intuitive responses (Moxley et al., 2012). Similarly, research on nudge effectiveness indicates that individuals prefer System 2 nudges, such as statistical information or detailed explanations, in high-stakes scenarios, as these align better with the need for careful consideration and reduced reliance on heuristics (Sunstein, 2016).

Moreover, studies in medical decision-making further substantiate this shift, illustrating that under high-stakes conditions, individuals actively seek deliberative engagement to ensure their decisions align with critical goals and values (Djulgovic et al., 2012). Reinforcement learning research echoes these findings, showing a clear preference for model-based, deliberative strategies when complexity and stakes are elevated (Kool et al., 2016). Finally, even in extreme altruistic decisions involving significant risk, individuals describe deliberative processes overriding initial impulsive responses, further supporting the idea that high stakes amplify the engagement of System 2 (Rand & Epstein, 2014).

To systematically investigate these processing mechanisms, we propose a multi-method research program combining behavioral experiments with process measures. Using a two-response paradigm (Thompson et al., 2011), participants would make decisions about defaults under varying stakes and complexity conditions, providing both an initial response under time pressure and cognitive load, followed by a deliberative response. This approach, validated in recent decision research (Bago & De Neys, 2019; Voudouri et al., 2024), could reveal whether high stakes and complexity truly shift processing modes or alter intuitive processing itself. Process measures including response times, mouse-tracking (Freeman & Ambady, 2010), and confidence ratings would provide convergent evidence about the underlying mechanisms.

The experimental design would systematically manipulate stakes through different monetary amounts, complexity through binary versus continuous choice formats, and administrative friction through varying effort requirements. These manipulations would occur while capturing initial versus final responses, processing indicators such as response times and movement trajectories, confidence ratings, and metacognitive measures. Individual differences in cognitive reflection and decision-making styles would be assessed to account for personal variation in default susceptibility. This comprehensive yet focused approach would help distinguish between competing theoretical accounts of how stakes and complexity influence default effectiveness, while maintaining practical relevance for intervention design in financial decision-making contexts. The results could clarify whether high-stakes decisions truly trigger more deliberative processing, as traditionally assumed, or instead alter the nature and interaction of multiple intuitive processes, as suggested by recent theoretical developments (De Neys, 2023; Van Dessel et al., 2022).

Cognitive Threshold Effects

Our findings suggest that decision complexity does not trigger a binary switch from passive to active decision-making, but rather increases the likelihood of deliberate processing as cognitive demands rise. This perspective aligns with dual-process research, which increasingly acknowledges that System 1 and System 2 are not separate modes but interact dynamically, with varying degrees of cognitive engagement depending on task complexity (Evans & Stanovich, 2013).

This extends existing work by highlighting specific conditions under which simplifying nudges may no longer suffice, requiring individuals to engage in more deliberate reasoning. Research on feedback complexity suggests that as decisions become more intricate, such as when time delays and dynamic dependencies are introduced, individuals are more likely to shift toward higher cognitive engagement (Diehl & Serman, 1995). Similarly, studies on active versus passive decision commitment demonstrate that deliberate, active choices foster stronger engagement and deeper cognitive processing (Cioffi & Garner, 1996). These findings further support the link between complexity and active decision-making.

Self-Generated Heuristics

These findings align with other studies demonstrating that clustering is a natural simplification strategy individuals employ to manage complexity. For instance, research shows that people often group decision variables into clusters to reduce cognitive load, blending heuristic and analytical approaches (Zhang et al., 2018). Moreover, the tendency to anchor decisions around round numbers is well-documented as a strategy to streamline choices under uncertainty, reflecting intuitive simplification mechanisms (Fränti & Virmajoki, 2006). Adaptive strategies that balance automatic and deliberative modes, such as clustering data into manageable segments, further highlight the dynamic interplay between cognitive systems in decision-making (Lee & Jung, 2017). Together, this evidence strengthens the case

that clustering behaviors are integral to understanding how individuals simplify continuous decision environments.

These insights challenge conventional wisdom about choice architecture design. While previous research emphasized simplification (Johnson et al., 2012; Thaler & Sunstein, 2008), our findings suggest that some complexity might actually benefit decision quality by promoting more thoughtful engagement. This aligns with emerging research on "smart defaults" (Smith et al., 2009) and suggests a need to recalibrate how we think about decision support tools.

For practitioners, these findings indicate that choice architecture should be calibrated to decision stakes and complexity. While simplifying nudges may work well for routine or lower-stakes decisions, more sophisticated choice support tools might be needed for complex financial choices. This could include hybrid approaches that combine simplified initial choices with opportunities for more detailed engagement.

Intervention Effectiveness Across the Life Cycle: Patterns and Implications

By examining behavioral interventions across multiple life stages, our research provides unique insights into how the effectiveness of different nudging categories evolves throughout the financial life cycle. Using Mertens et al.'s (2022) framework of decision structure (DS), decision assistance (DA), and decision information (DI) interventions, we can map patterns of effectiveness that challenge existing assumptions about behavioral interventions in retirement planning.

Early Life Stage: Building Financial Habits

In early adulthood, when individuals first encounter independent financial decisions, DS interventions showed particular promise. The effectiveness of "set-and-forget" defaults in promoting micro-investing (Chapter 2) suggests that reducing friction and leveraging automaticity can successfully establish beneficial financial habits. This aligns with research

showing the importance of early financial socialization (LeBaron & Kelley, 2021; Oehler et al., 2018) while extending our understanding of how choice architecture can support habit formation.

However, even at this stage, intervention effectiveness varied by type. While DS succeeded, DI interventions like social norms showed limited impact. This pattern suggests that young adults may be more responsive to interventions that reduce barriers to action rather than those that attempt to influence through social comparison or information provision. This aligns with literature emphasizing the superiority of action-oriented DS interventions in simplifying decision-making (Altman, 2012; Jin et al., 2018), while DI approaches, including social norms, often fail due to misalignment with individual realities (Samuel et al., 2023; Silva & John, 2017). However, counterintuitive findings, such as the ineffectiveness of social norms in financial contexts despite their success in areas like public health (Perkins et al., 2010), highlight the importance of context-specific intervention design.

Mid-Career Stage: Pension Participation

During peak earning years, when individuals face decisions about occupational pension participation, we observed more complex patterns. Despite being substantially less effective compared with prior studies in a U.S. based context (Benartzi & Thaler, 2013; Beshears et al., 2009), DS interventions remained effective but showed sensitivity to implementation details. For example, default effects persisted even with substantial administrative friction (Chapter 4).

DA interventions, particularly pre-commitment strategies, showed modest but consistent effectiveness during this stage. This extends previous findings about commitment devices in retirement savings (Thaler & Benartzi, 2004) while suggesting that their effectiveness may be influenced by institutional context.

Late Career Stage: Decumulation Decisions

As individuals approached retirement and/or faced complex decumulation decisions, traditional behavioral interventions showed surprisingly reduced effectiveness. Neither DS, DA, nor DI interventions significantly influenced annuitization choices in our mega-study (Chapter 5). This declining effectiveness pattern challenges assumptions about the universal applicability of behavioral interventions and suggests a need for more sophisticated approaches to supporting complex financial decisions, in line with recent findings from Maier et al. (2022) and Szaszi et al. (2022).

We identify several key principles about life-cycle intervention effectiveness:

1. Diminishing Returns Principle: The effectiveness of behavioral interventions generally decreases as decision complexity and stakes increase across the life cycle.
2. Context Sensitivity Principle: Intervention effectiveness depends not just on life stage but on the interaction between decision type, stakes, and institutional context.
3. Engagement Evolution Principle: As individuals progress through the life cycle, they appear more likely to engage in deliberative processing for financial decisions, potentially reducing the effectiveness of interventions that rely on automatic processing.

These principles have important implications for both theory and practice. They suggest that behavioral interventions in the context of retirement decisions in a European setting need careful calibration to life stage and decision context, challenging the "one-size-fits-all" approach often taken in retirement policy. For financial institutions and policy makers, this implies a need for more differentiated intervention strategies that evolve with the individual's life cycle position.

Furthermore, our findings suggest that the traditional categorization of nudges (DS/DA/DI) might benefit from incorporating life-cycle and context dimensions. This could

lead to more nuanced intervention design that accounts for how different nudge types interact with life stage and decision characteristics.

Theoretical Implications and Future Directions

This dissertation's systematic examination of behavioral interventions across the financial life cycle advances our theoretical understanding of human decision-making while highlighting crucial directions for future research. Our findings contribute to multiple theoretical frameworks and suggest important refinements to existing models.

First, our research significantly extends behavioral economic theory by identifying critical boundary conditions for nudge effectiveness and revealing underlying mechanisms that help explain recent mixed evidence about nudge impacts (DellaVigna & Linos, 2022; Szaszi et al., 2022). The variable effectiveness of defaults across decision contexts aligns with emerging theoretical perspectives that challenge traditional dual-process accounts. Rather than viewing decisions as simply shifting between intuitive and deliberative modes, our findings support newer theoretical frameworks suggesting multiple competing intuitions operate simultaneously (De Neys, 2023; Voudouri et al., 2024). This can potentially explain why increased complexity doesn't necessarily trigger pure deliberation but may instead alter the interaction between different types of intuitive processing. Similarly, our finding that social influences lose power in strong welfare state contexts contributes to theory by demonstrating how institutional environments moderate basic psychological mechanisms. This extends recent work on how cultural and institutional contexts shape cognitive processes (Muthukrishna et al., 2020) and suggests the need for more sophisticated models of how behavioral interventions interact with broader societal structures.

Second, we advance life-cycle theory by demonstrating systematic variation in behavioral mechanisms across the financial life course. While traditional life-cycle models assume relatively stable decision-making processes (Modigliani, 1986), our findings reveal

how cognitive mechanisms and intervention effectiveness evolve through different life stages. This aligns with recent theoretical work on the development of decision-making capabilities (de Bruin et al., 2012; Peters et al., 2019) and suggests the need for a more dynamic model incorporating both cognitive maturation and experiential learning. Our results show how financial decision-making reflects an interaction between universal cognitive mechanisms, individual development, and institutional context. This extends emerging theoretical perspectives on how decision-making capabilities develop through experience while being shaped by environmental affordances (Hertwig & Grüne-Yanoff, 2017; Van Dessel et al., 2022). The varying effectiveness of individually-framed versus socially-framed nudges across contexts also suggests that intervention success depends on how well the framing aligns with both individual characteristics and institutional environments (Chater & Loewenstein, 2022). In strong welfare states, for instance, social frames may lose potency as financial decisions become more individually oriented. However, focusing solely on universal patterns overlooks crucial individual differences in how people respond to behavioral interventions.

Our findings highlight the critical need to understand individual variation in intervention responsiveness. While behavioral economics has traditionally focused on average treatment effects, the variable effectiveness of interventions across individuals suggests the importance of behavioral phenotyping, identifying clusters of psychological characteristics that predict how people respond to different types of nudges. Recent evidence indicates systematic variation in how individuals respond to behavioral interventions based on factors like cognitive reflection tendencies (Ibrahim et al., 2021), financial self-efficacy (Chowdhry & Dholakia, 2020), and decision-making styles (Peer et al., 2020). Understanding these person-by-situation interactions could enable more sophisticated "precision nudging" approaches that match specific interventions to individual characteristics, similar to developments in personalized medicine.

Third, our identification of the "complexity-engagement paradox" contributes to choice architecture theory by revealing non-linear relationships between decision complexity and processing depth. While conventional wisdom suggests simplification generally improves decision-making (Thaler & Sunstein, 2008), our findings show how moderate complexity can trigger more thoughtful engagement that may improve choice quality. This aligns with recent theoretical work on the benefits of "desirable difficulties" in learning and decision-making (Bjork & Bjork, 2011) and suggests the need to move beyond simple prescriptions for choice architecture design. The paradox also connects to broader theoretical debates about rational versus ecological approaches to decision-making (Gigerenzer & Todd, 1999) and indicates how environmental complexity may sometimes support rather than impede effective choice.

These theoretical contributions suggest several important directions for future research. First, we need more sophisticated models of how different types of intuitive processing interact in financial decisions. This could build on recent advances in cognitive science (De Neys, 2023) while incorporating insights about institutional and cultural moderation of psychological mechanisms. Second, longitudinal research should examine how financial decision-making capabilities develop across the life course, focusing on interaction between cognitive maturation, experiential learning, and institutional context. Third, we need better theoretical understanding of when complexity helps versus hinders decision quality, perhaps through computational modeling of how different processing mechanisms respond to varying levels of environmental complexity.

Future work should also expand beyond traditional behavioral economic frameworks to incorporate insights from other disciplines. Integration with research on cognitive development, cultural evolution, and ecological rationality could help build more comprehensive models of financial decision-making. Additionally, emerging work on how digital technologies shape cognitive processes (Marsh & Rajaram, 2019) suggests the need to

understand how behavioral interventions operate in increasingly digital financial environments.

Finally, methodological advances are needed to better test these theoretical refinements. This could include more sophisticated process-tracing methods to examine multiple competing intuitions, longitudinal designs to track developmental trajectories, and computational models to formalize theoretical predictions about how different mechanisms interact. Cross-cultural and cross-institutional studies could help isolate contextual effects, while field experiments could test theoretical predictions in real-world settings.

This expanded theoretical framework has important implications for policy and intervention design. Rather than assuming universal effectiveness of behavioral interventions, policymakers need more nuanced approaches that account for life-stage effects, institutional context, and the sometimes counter-intuitive benefits of moderate complexity. Success requires moving beyond simple nudges toward more sophisticated choice architecture that works with rather than against natural decision-making processes.

This dissertation underscores several additional avenues for future research that can enrich our understanding of behavioral interventions in retirement decision-making. A critical area involves examining the interaction of nudges with individual differences such as financial literacy, personality traits, interests, and financial self-efficacy. While these variables were beyond the scope of the current research, which focused on testing the effectiveness of different types of nudges across the life cycle, their inclusion in subsequent analyses of the collected data could provide deeper insights into who responds most effectively to specific interventions at different life stages. Behavioral phenotyping, supported by advancements in big data and AI, offers a promising pathway for uncovering these dynamics (Ibrahim et al., 2021; Kosinski et al., 2013). Scholars increasingly advocate for this type of research,

suggesting it could refine the tailoring of nudges to individual characteristics and contexts, enhancing their overall effectiveness (Feuerriegel et al., 2025; Mills et al., 2023).

The integration of AI-driven technologies, such as natural language processing (NLP) and behavioral chatbots, has rapidly evolved since the start of this PhD in 2020, offering unprecedented opportunities in decision-making (Feuerriegel et al., 2025). In just five years, AI has progressed from theoretical frameworks to widely adopted tools, reshaping how interventions are designed and delivered. Recent advances demonstrate how AI tools can mimic human and collective behaviors, paving the way for personalized pension advisor systems (He et al., 2024). These systems employ *hypernudging*, dynamic, AI-driven adaptations based on individual data, to custom-nudge individuals according to their unique behavioral profiles (Leal & Oliveira, 2024). Such hypernudges leverage digital platforms and personalization to optimize financial decision-making, providing tools like financial assistants and recommender systems that align with users' specific goals and behaviors. Additionally, AI-assisted nudging transforms traditional interventions by incorporating dynamic, real-time feedback loops and gamification elements, making financial planning more engaging and interactive.

Despite these advancements, foundational research remains essential to explore how specific interventions interact with individual and contextual variables under varying circumstances. This includes understanding the limits of hypernudging, addressing potential user reactance, and critically evaluating ethical and regulatory frameworks to ensure responsible implementation in financial contexts.

Further, the mega-study approach, utilized in chapter 5 of this dissertation, highlights the importance of capturing both significant and null findings. Null results, often overlooked and plagued by the file-drawer problem¹ (Laitin et al., 2021), are critical for identifying the

¹ A phenomenon in behavioral science where null results are notoriously hard to get published.

boundary conditions of behavioral interventions. This methodological framework ensures that even non-significant outcomes contribute to the literature, enhancing the reproducibility and transparency of behavioral science (Duckworth & Milkman, 2022). Encouraging the publication of such results can shift the focus from solely positive findings to a more comprehensive understanding of intervention effectiveness.

Lastly, future research should evaluate not only the statistical significance, but also the return on investment (ROI) of nudges, calculating the cost-effectiveness of these interventions per euro spent in a European context, across the life-cycle to help determine where intervention resources are best spent. While behavioral interventions are often praised for their cost-efficiency (Benartzi et al., 2017), diminishing effectiveness in some contexts raises questions about their continued deployment. For instance, analyzing whether the marginal benefits of nudges justify their costs compared to alternative approaches, such as financial incentives or educational programs, would provide policymakers with a clearer framework for resource allocation (Hummel & Maedche, 2019). By combining rigorous ROI analysis with insights from behavioral phenotyping and AI across the life-cycle, future research can advance the design and deployment of interventions that maximize both individual and societal benefits.

Practical Implications

The findings of this dissertation offer valuable guidance for practitioners and policymakers seeking to enhance pension decision-making and address the challenges posed by behavioral barriers in a European welfare state context. By leveraging these insights, interventions can be tailored to achieve greater impact while respecting individual autonomy. Below, we outline key practical implications and recommendations.

First, behavioral interventions must be calibrated to life stages and decision complexity. Early-life decisions, such as micro-investing or initiating pension contributions,

benefit from interventions that reduce friction and leverage automaticity, such as defaults or pre-commitment strategies. However, as individuals progress through their financial life cycle, more complex decisions, such as decumulation or annuitization, appear to more actively engage individuals in deliberative thinking, subsequently influencing intervention effectiveness. Simplified nudges may therefore lose their effectiveness in high-stakes scenarios, emphasizing the need for hybrid approaches that combine streamlined initial steps with opportunities for in-depth engagement.

Second, the institutional context plays a critical role in shaping intervention outcomes. Findings from this PhD dissertation indicate that behavioral interventions successful in one setting may not necessarily transfer to another without careful adaptation. For example, the robust social safety nets in European welfare states may reduce the urgency of pension participation compared to contexts like the United States. Policymakers must consider cultural and institutional differences when designing or adopting interventions, ensuring they align with local expectations and norms.

Third, supporting complex decumulation decisions requires more sophisticated tools and frameworks. Decumulation choices, such as annuitization, are highly consequential yet often marked by psychological distance and decision paralysis. Our findings from the Chapter 5 experiment demonstrate that providing continuous choices reveals strong preferences among individuals, with a tendency to gravitate toward round numbers such as 0%, 50%, or 100%. These preferences appear resistant to traditional behavioral mechanisms, highlighting the limitations of standard nudging approaches in influencing such decisions. However, our study also reveals a promising market for annuities in Belgium, with more than 50% of participants expressing interest in annuitizing a portion of their wealth. Policy interventions should build on these insights by exploring innovative choice architectures that address cognitive overload and decision rigidity. Approaches such as phased decision-making or

interactive digital tools that allow individuals to simulate various retirement scenarios and the long-term consequences of various decisions, could better accommodate these preferences while encouraging thoughtful engagement.

Fourth, integrating insights about psychological distance and engagement into choice architecture design is crucial. Interventions that make distant outcomes feel more immediate and tangible, such as reframing contributions in daily terms, have demonstrated effectiveness in this research. Policymakers and practitioners should employ strategies that reduce psychological distance, such as leveraging temporal landmarks or creating visual representations of future benefits, to encourage active participation in pension planning.

Beyond these core recommendations, several additional implications warrant attention. The increasing adoption of AI and digital platforms presents an opportunity to refine interventions further. Hyper nudging, for instance, can dynamically adapt interventions to individual characteristics and real-time behaviors, enabling more precise targeting. However, policymakers must address ethical and regulatory concerns, ensuring transparency and fairness in the use of AI-driven tools. Moreover, the importance of evaluating the return on investment (ROI) of behavioral interventions cannot be overstated. By assessing the cost-effectiveness of nudges compared to alternative approaches, such as financial incentives or educational initiatives, practitioners can make informed decisions about resource allocation.

Finally, this dissertation underscores the value of null findings and rigorous evaluation in advancing the field. By openly acknowledging limitations and boundary conditions, researchers and policymakers can refine their strategies, avoiding overreliance on interventions that may underperform in specific contexts. Encouraging the publication and consideration of null results fosters a more nuanced and effective approach to improving retirement security.

Conclusion

As societies worldwide grapple with demographic shifts and pension system pressures, the need for effective behavioral interventions in retirement planning becomes increasingly urgent. Our research suggests both the promise and limitations of such interventions while highlighting the importance of contextual factors and life-cycle effects. Moving forward, the challenge will be developing more sophisticated approaches that can support better financial decisions while accounting for the complex realities of modern retirement planning in an increasingly digital world.

References

- Altman, M. (2012). Implications of behavioural economics for financial literacy and public policy. *The Journal of Socio-Economics*, 41(5), 677–690.
<https://doi.org/10.1016/j.socec.2012.06.002>
- Anderson, K. (2015). Pension Reform in Europe: Context, Drivers, Impact. In S. Scherger (Ed.), *Paid Work Beyond Pension Age: Comparative Perspectives* (pp. 177–197). Palgrave Macmillan UK. https://doi.org/10.1057/9781137435149_8
- Ando, A., & Modigliani, F. (1963). The “Life Cycle” Hypothesis of Saving: Aggregate Implications and Tests. *The American Economic Review*, 53(1), 55–84.
- Bago, B., & De Neys, W. (2019). The intuitive greater good: Testing the corrective dual process model of moral cognition. *Journal of Experimental Psychology: General*, 148(10), 1782–1801. <https://doi.org/10.1037/xge0000533>
- Benartzi, S., Beshears, J., Milkman, K. L., Sunstein, C. R., Thaler, R. H., Shankar, M., Tucker-Ray, W., Congdon, W. J., & Galing, S. (2017). Should Governments Invest More in Nudging? *PSYCHOLOGICAL SCIENCE*, 28(8), 1041–1055.
<https://doi.org/10.1177/0956797617702501>
- Benartzi, S., & Thaler, R. H. (2013). Behavioral Economics and the Retirement Savings Crisis. *SCIENCE*, 339(6124), 1152–1153. <https://doi.org/10.1126/science.1231320>
- Beshears, J., Choi, J. J., Laibson, D., & Madrian, B. C. (2009). The Importance of Default Options for Retirement Saving Outcomes: Evidence from the United States. *NBER Chapters*, 167–195.
- Beshears, J., Choi, J. J., Laibson, D., Madrian, B. C., & Milkman, K. L. (2015). The Effect of Providing Peer Information on Retirement Savings Decisions. *The Journal of Finance*, 70(3), 1161–1201. <https://doi.org/10.1111/jofi.12258>

- Bjork, E. L., & Bjork, R. A. (2011). Making things hard on yourself, but in a good way: Creating desirable difficulties to enhance learning. In *Psychology and the real world: Essays illustrating fundamental contributions to society* (pp. 56–64). Worth Publishers.
- Carroll, G. D., Choi, J. J., Laibson, D., Madrian, B. C., & Metrick, A. (2009). Optimal Defaults and Active Decisions*. *The Quarterly Journal of Economics*, 124(4), 1639–1674. <https://doi.org/10.1162/qjec.2009.124.4.1639>
- Castellino, O., Fornero, E., & Wilke, C. B. (2020). *Pension Policy in Europe and the United States – Towards a New Public-Private Pension Mix* (SSRN Scholarly Paper No. 3565087). Social Science Research Network. <https://doi.org/10.2139/ssrn.3565087>
- Chater, N., & Loewenstein, G. (2022). *The i-Frame and the s-Frame: How Focusing on Individual-Level Solutions Has Led Behavioral Public Policy Astray* (SSRN Scholarly Paper No. 4046264). Social Science Research Network. <https://doi.org/10.2139/ssrn.4046264>
- Chowdhry, N., & Dholakia, U. M. (2020). Know thyself financially: How financial self-awareness can benefit consumers and financial advisors. *FINANCIAL PLANNING REVIEW*, 3(1), e1069. <https://doi.org/10.1002/cfp2.1069>
- Cialdini, R. B., & Trost, M. R. (1998). Social influence: Social norms, conformity and compliance. In *The handbook of social psychology, Vols. 1-2, 4th ed* (pp. 151–192). McGraw-Hill.
- Cioffi, D., & Garner, R. (1996). On Doing the Decision: Effects of Active versus Passive Choice on Commitment and Self-Perception. *Personality and Social Psychology Bulletin*, 22(2), 133–147. <https://doi.org/10.1177/0146167296222003>

- Dai, H., Milkman, K. L., & Riis, J. (2014). The Fresh Start Effect: Temporal Landmarks Motivate Aspirational Behavior. *Management Science*, 60(10), 2563–2582.
<https://doi.org/10.1287/mnsc.2014.1901>
- de Bruin, W. B., Parker, A. M., & Fischhoff, B. (2012). Explaining adult age differences in decision-making competence. *Journal of Behavioral Decision Making*, 25(4), 352–360. <https://doi.org/10.1002/bdm.712>
- De Neys, W. (2023). Further advancing fast-and-slow theorizing. *Behavioral and Brain Sciences*, 46, e146. <https://doi.org/10.1017/S0140525X23000559>
- de Ridder, D., Kroese, F., & van Gestel, L. (2022). Nudgeability: Mapping Conditions of Susceptibility to Nudge Influence. *Perspectives on Psychological Science*, 17(2), 346–359. <https://doi.org/10.1177/1745691621995183>
- DellaVigna, S., & Linos, E. (2022). RCTs to Scale: Comprehensive Evidence From Two Nudge Units. *Econometrica*, 90(1), 81–116. <https://doi.org/10.3982/ECTA18709>
- Diehl, E., & Sterman, J. D. (1995). Effects of Feedback Complexity on Dynamic Decision Making. *Organizational Behavior and Human Decision Processes*, 62(2), 198–215.
<https://doi.org/10.1006/obhd.1995.1043>
- Djulbegovic, B., Hozo, I., Beckstead, J., Tsalatsanis, A., & Pauker, S. G. (2012). Dual processing model of medical decision-making. *BMC Medical Informatics and Decision Making*, 12(1), 94. <https://doi.org/10.1186/1472-6947-12-94>
- Duckworth, A. L., & Milkman, K. L. (2022). A guide to megastudies. *PNAS Nexus*, 1(5), pgac214. <https://doi.org/10.1093/pnasnexus/pgac214>
- Duflo, E., & Saez, E. (2002). Participation and investment decisions in a retirement plan: The influence of colleagues' choices. *Journal of Public Economics*, 85(1), 121–148.

- Dur, R., Fleming, D., van Garderen, M., & van Lent, M. (2021). A social norm nudge to save more: A field experiment at a retail bank. *Journal of Public Economics*, 200, 104443. <https://doi.org/10.1016/j.jpubeco.2021.104443>
- Feuerriegel, S., Maarouf, A., Bär, D., Geissler, D., Schweisthal, J., Pröllochs, N., Robertson, C. E., Rathje, S., Hartmann, J., Mohammad, S. M., Netzer, O., Siegel, A. A., Plank, B., & Van Bavel, J. J. (2025). Using natural language processing to analyse text data in behavioural science. *Nature Reviews Psychology*, 1–16. <https://doi.org/10.1038/s44159-024-00392-z>
- Fränti, P., & Virtajoki, O. (2006). Iterative shrinking method for clustering problems. *Pattern Recognition*, 39(5), 761–775. <https://doi.org/10.1016/j.patcog.2005.09.012>
- Freeman, J. B., & Ambady, N. (2010). MouseTracker: Software for studying real-time mental processing using a computer mouse-tracking method. *Behavior Research Methods*, 42(1), 226–241. <https://doi.org/10.3758/BRM.42.1.226>
- Gigerenzer, G., & Todd, P. M. (1999). Fast and frugal heuristics: The adaptive toolbox. In *Simple heuristics that make us smart* (pp. 3–34). Oxford University Press.
- Gourville, J. T. (1998). Pennies-a-Day: The Effect of Temporal Reframing on Transaction Evaluation. *Journal of Consumer Research*, 24(4), 395–408. <https://doi.org/10.1086/209517>
- Hainmueller, J., Hangartner, D., & Yamamoto, T. (2015). Validating vignette and conjoint survey experiments against real-world behavior. *Proceedings of the National Academy of Sciences*, 112(8), 2395–2400. <https://doi.org/10.1073/pnas.1416587112>
- He, J. K., Wallis, F. P. S., Gvartz, A., & Rathje, S. (2024). Artificial intelligence chatbots mimic human collective behaviour. *British Journal of Psychology*, n/a(n/a). <https://doi.org/10.1111/bjop.12764>

- Hertwig, R., & Grüne-Yanoff, T. (2017). Nudging and Boosting: Steering or Empowering Good Decisions. *Perspectives on Psychological Science*, 12(6), 973–986.
<https://doi.org/10.1177/1745691617702496>
- Hummel, D., & Maedche, A. (2019). How effective is nudging? A quantitative review on the effect sizes and limits of empirical nudging studies. *Journal of Behavioral and Experimental Economics*, 80, 47–58. <https://doi.org/10.1016/j.socec.2019.03.005>
- Ibrahim, A., Zhang, H., Clinch, S., Poliakoff, E., Parsia, B., & Harper, S. (2021). Digital Phenotypes for Understanding Individuals' Compliance With COVID-19 Policies and Personalized Nudges: Longitudinal Observational Study. *JMIR Formative Research*, 5(5), e23461. <https://doi.org/10.2196/23461>
- Jachimowicz, J. M., Duncan, S., Weber, E. U., & Johnson, E. J. (2019). When and why defaults influence decisions: A meta-analysis of default effects. *Behavioural Public Policy*, 3(2), 159–186. <https://doi.org/10.1017/bpp.2018.43>
- Jin, M., Wang, H., Zhang, Q., & Luo, C. (2018). Financial Management and Decision Based on Decision Tree Algorithm. *Wireless Personal Communications*, 102(4), 2869–2884. <https://doi.org/10.1007/s11277-018-5312-6>
- Johnson, E. J., Shu, S. B., Dellaert, B. G. C., Fox, C., Goldstein, D. G., Häubl, G., Larrick, R. P., Payne, J. W., Peters, E., Schkade, D., Wansink, B., & Weber, E. U. (2012). Beyond nudges: Tools of a choice architecture. *Marketing Letters*, 23(2), 487–504. <https://doi.org/10.1007/s11002-012-9186-1>
- Kahneman, D. (2011). *Thinking, fast and slow*. Farrar, Straus and Giroux.
- Kalkstein, D. A., Lima, F. D., Brady, S. T., Rozek, C. S., Johnson, E. J., & Walton, G. M. (2022). Defaults are not a panacea: Distinguishing between default effects on choices and on outcomes. *Behavioural Public Policy*, 1–16. <https://doi.org/10.1017/bpp.2022.24>

- Koch, A. K., Mønster, D., & Nafziger, J. (2024). Spillover effects of reminder nudges in complex environments. *Proceedings of the National Academy of Sciences*, 121(17), e2322549121. <https://doi.org/10.1073/pnas.2322549121>
- Kool, W., Cushman, F. A., & Gershman, S. J. (2016). When Does Model-Based Control Pay Off? *PLOS Computational Biology*, 12(8), e1005090. <https://doi.org/10.1371/journal.pcbi.1005090>
- Kosinski, M., Stillwell, D., & Graepel, T. (2013). Private traits and attributes are predictable from digital records of human behavior. *Proceedings of the National Academy of Sciences*, 110(15), 5802–5805. <https://doi.org/10.1073/pnas.1218772110>
- Kruglanski, A. W., Chernikova, M., Babush, M., Dugas, M., & Schumpe, B. M. (2015). Chapter Three - The Architecture of Goal Systems: Multifinality, Equifinality, and Counterfinality in Means—End Relations. In A. J. Elliot (Ed.), *Advances in Motivation Science* (Vol. 2, pp. 69–98). Elsevier. <https://doi.org/10.1016/bs.adms.2015.04.001>
- Laibson, D. (1997). Golden Eggs and Hyperbolic Discounting. *The Quarterly Journal of Economics*, 112(2), 443–477.
- Laitin, D. D., Miguel, E., Alrababa'h, A., Bogdanoski, A., Grant, S., Hoerberling, K., Hyunjung Mo, C., Moore, D. A., Vazire, S., Weinstein, J., & Williamson, S. (2021). Reporting all results efficiently: A RARE proposal to open up the file drawer. *Proceedings of the National Academy of Sciences of the United States of America*, 118(52), e2106178118. <https://doi.org/10.1073/pnas.2106178118>
- Leal, C. C., & Oliveira, B. (2024). Chapter Six—Nudging financial behavior in the age of artificial intelligence. In C. Machado & J. P. Davim (Eds.), *Artificial Intelligence in Production Engineering and Management* (pp. 115–144). Woodhead Publishing. <https://doi.org/10.1016/B978-0-12-819471-3.00002-1>

- LeBaron, A. B., & Kelley, H. H. (2021). Financial Socialization: A Decade in Review. *Journal of Family and Economic Issues*, 42(1), 195–206.
<https://doi.org/10.1007/s10834-020-09736-2>
- Lee, O.-J., & Jung, J. E. (2017). Sequence Clustering-based Automated Rule Generation for Adaptive Complex Event Processing. *Future Generation Computer Systems*, 66, 100–109. <https://doi.org/10.1016/j.future.2016.02.011>
- Li, W., Gleeson, J., Fraser, M. I., Ciarrochi, J., Hofmann, S. G., Hayes, S. C., & Sahdra, B. (2024). The efficacy of personalized psychological interventions in adolescents: A scoping review and meta-analysis. *Frontiers in Psychology*, 15.
<https://doi.org/10.3389/fpsyg.2024.1470817>
- Madrian, B. C., & Shea, D. F. (2001). The Power of Suggestion: Inertia in 401(k) Participation and Savings Behavior*. *The Quarterly Journal of Economics*, 116(4), 1149–1187. <https://doi.org/10.1162/003355301753265543>
- Maier, M., Bartoš, F., Stanley, T. D., Shanks, D. R., Harris, A. J. L., & Wagenmakers, E.-J. (2022). No evidence for nudging after adjusting for publication bias. *Proceedings of the National Academy of Sciences*, 119(31), e2200300119.
<https://doi.org/10.1073/pnas.2200300119>
- Marsh, E. J., & Rajaram, S. (2019). The digital expansion of the mind: Implications of internet usage for memory and cognition. *Journal of Applied Research in Memory and Cognition*, 8(1), 1–14. <https://doi.org/10.1016/j.jarmac.2018.11.001>
- Mertens, S., Herberz, M., Hahnel, U. J. J., & Brosch, T. (2022). The effectiveness of nudging: A meta-analysis of choice architecture interventions across behavioral domains. *Proceedings of the National Academy of Sciences of the United States of America*, 119(1), e2107346118. <https://doi.org/10.1073/pnas.2107346118>

- Miles, D. (2023). Macroeconomic impacts of changes in life expectancy and fertility. *The Journal of the Economics of Ageing*, 24, 100425.
<https://doi.org/10.1016/j.jeoa.2022.100425>
- Mills, S. (2022). Personalized nudging. *Behavioural Public Policy*, 6(1), 150–159.
<https://doi.org/10.1017/bpp.2020.7>
- Mills, S., Costa, S., & Sunstein, C. R. (2023). *The Opportunities and Costs of AI in Behavioural Science* (SSRN Scholarly Paper No. 4490597). Social Science Research Network. <https://doi.org/10.2139/ssrn.4490597>
- Mitchell, O., & Lusardi, A. (2011). *Financial Literacy: Implications for Retirement Security and the Financial Marketplace* [OUP Catalogue]. Oxford University Press.
<https://econpapers.repec.org/bookchap/oxpobooks/9780199696819.htm>
- Modigliani, F. (1986). Life Cycle, Individual Thrift, and the Wealth of Nations. *The American Economic Review*, 76(3), 297–313.
- Moxley, J. H., Anders Ericsson, K., Charness, N., & Krampe, R. T. (2012). The role of intuition and deliberative thinking in experts' superior tactical decision-making. *Cognition*, 124(1), 72–78. <https://doi.org/10.1016/j.cognition.2012.03.005>
- Muthukrishna, M., Bell, A. V., Henrich, J., Curtin, C. M., Gedranovich, A., McInerney, J., & Thue, B. (2020). Beyond Western, Educated, Industrial, Rich, and Democratic (WEIRD) Psychology: Measuring and Mapping Scales of Cultural and Psychological Distance. *Psychological Science*, 31(6), 678–701.
<https://doi.org/10.1177/0956797620916782>
- O'Donoghue, T., & Rabin, M. (2015). Present Bias: Lessons Learned and to Be Learned. *American Economic Review*, 105(5), 273–279. <https://doi.org/10.1257/aer.p20151085>
- OECD. (2023). *Pensions at a Glance 2023*. <https://www.oecd-ilibrary.org/content/publication/678055dd-en>

- Oehler, A., Horn, M., & Wedlich, F. (2018). *Young Adults' Subjective and Objective Risk Attitude in Financial Decision Making: Evidence From the Lab and the Field* (SSRN Scholarly Paper No. 3308505). Social Science Research Network.
<https://papers.ssrn.com/abstract=3308505>
- Peer, E., Egelman, S., Harbach, M., Malkin, N., Mathur, A., & Frik, A. (2020). Nudge me right: Personalizing online security nudges to people's decision-making styles. *Computers in Human Behavior*, 109, 106347.
<https://doi.org/10.1016/j.chb.2020.106347>
- Pennycook, G., Fugelsang, J. A., & Koehler, D. J. (2015). Everyday Consequences of Analytic Thinking. *Current Directions in Psychological Science*, 24(6), 425–432.
<https://doi.org/10.1177/0963721415604610>
- Perkins, H. W., Linkenbach, J. W., Lewis, M. A., & Neighbors, C. (2010). Effectiveness of social norms media marketing in reducing drinking and driving: A statewide campaign. *Addictive Behaviors*, 35(10), 866–874.
<https://doi.org/10.1016/j.addbeh.2010.05.004>
- Peters, E., Tompkins, M. K., Knoll, M. A. Z., Ardoin, S. P., Shoots-Reinhard, B., & Meara, A. S. (2019). Despite high objective numeracy, lower numeric confidence relates to worse financial and medical outcomes. *Proceedings of the National Academy of Sciences of the United States of America*, 116(39), 19386–19391.
<https://doi.org/10.1073/pnas.1903126116>
- Pope, D., & Simonsohn, U. (2011). Round Numbers as Goals: Evidence From Baseball, SAT Takers, and the Lab. *Psychological Science*, 22(1), 71–79.
<https://doi.org/10.1177/0956797610391098>

- Rand, D. G., & Epstein, Z. (2014). *Risking Your Life Without a Second Thought: Intuitive Decision-Making and Extreme Altruism* (SSRN Scholarly Paper No. 2424036). Social Science Research Network. <https://doi.org/10.2139/ssrn.2424036>
- Raue, M., D'Ambrosio, L. A., & Coughlin, J. F. (2020). The Power of Peers: Prompting Savings Behavior Through Social Comparison. *Journal of Behavioral Finance*, 21(1), 1–13. <https://doi.org/10.1080/15427560.2019.1587762>
- Samuel, L. J., Wright, R., Taylor, J., Roberts Lavigne, L. C., & Szanton, S. L. (2023). Social Norms About Handling Financial Challenges in Relation to Health-Protective Capacity Among Low-Income Older Adults. *The Gerontologist*, 63(4), 783–794. <https://doi.org/10.1093/geront/gnac061>
- Silva, A., & John, P. (2017). Social norms don't always work: An experiment to encourage more efficient fees collection for students. *PloS One*, 12(5), e0177354. <https://doi.org/10.1371/journal.pone.0177354>
- Smith, N. C., Goldstein, D. G., & Johnson, E. J. (2009). *Smart Defaults: From Hidden Persuaders to Adaptive Helpers* (SSRN Scholarly Paper No. 1116650). Social Science Research Network. <https://doi.org/10.2139/ssrn.1116650>
- Sunstein, C. R. (2016). *People Prefer System 2 Nudges (Kind Of)* (SSRN Scholarly Paper No. 2731868). Social Science Research Network. <https://doi.org/10.2139/ssrn.2731868>
- Szaszi, B., Higney, A., Charlton, A., Gelman, A., Ziano, I., Aczel, B., Goldstein, D. G., Yeager, D. S., & Tipton, E. (2022). No reason to expect large and consistent effects of nudge interventions. *Proceedings of the National Academy of Sciences*, 119(31), e2200732119. <https://doi.org/10.1073/pnas.2200732119>
- Thaler, R. (1985). Mental Accounting and Consumer Choice. *Marketing Science*, 4(3), 199–214.

- Thaler, R. H., & Benartzi, S. (2004). Save More TomorrowTM: Using Behavioral Economics to Increase Employee Saving. *Journal of Political Economy*, 112(S1), S164–S187.
<https://doi.org/10.1086/380085>
- Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decisions about health, wealth, and happiness* (pp. x, 293). Yale University Press.
- Thompson, V. A., Prowse Turner, J. A., & Pennycook, G. (2011). Intuition, reason, and metacognition. *Cognitive Psychology*, 63(3), 107–140.
<https://doi.org/10.1016/j.cogpsych.2011.06.001>
- Trope, Y., & Liberman, N. (2010). Construal-level theory of psychological distance. *Psychological Review*, 117(2), 440–463. <https://doi.org/10.1037/a0018963>
- Van Bavel, J. (2013). The world population explosion: Causes, backgrounds and projections for the future. *Facts, Views & Vision in ObGyn*, 5(4), 281–291.
- Van Dessel, P., Boddez, Y., & Hughes, S. (2022). Nudging societally relevant behavior by promoting cognitive inferences. *Scientific Reports*, 12(1), Article 1.
<https://doi.org/10.1038/s41598-022-12964-1>
- Vandresse, M. (2021). *Demographic outlook 2020-2070* (Forecasts & Outlook No. POP2070_12389; Belgian Demographic Outlook). Federal Planning Bureau.
https://www.plan.be/publications/publication-2104-en-2020_2070_2020_2070_demographic_outlook_reference_alternative_scenarios
- Voudouri, A., Białek, M., & De Neys, W. (2024). Fast & slow decisions under risk: Intuition rather than deliberation drives advantageous choices. *Cognition*, 250, 105837.
<https://doi.org/10.1016/j.cognition.2024.105837>
- Zhang, X., Tian, Y., Cheng, R., & Jin, Y. (2018). A Decision Variable Clustering-Based Evolutionary Algorithm for Large-Scale Many-Objective Optimization. *IEEE*

Transactions on Evolutionary Computation, 22(1), 97–112. IEEE Transactions on Evolutionary Computation. <https://doi.org/10.1109/TEVC.2016.2600642>

Data Storage Fact Sheets

Chapter 2

Name/identifier study: PhD Mathias Celis - Chapter 2

Author: Mathias Celis

Date: 18/01/2025

1. Contact details

1a. Main researcher

- name: Mathias Celis
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If a response is not received when using the above contact details, please send an email to data.pp@ugent.be or contact Data Management, Faculty of Psychology and Educational Sciences, Henri Dunantlaan 2, 9000 Ghent, Belgium.

2. Information about the datasets to which this sheet applies

* Reference of the publication in which the datasets are reported:

Celis, M. (2025). Nudging pension saving decisions. (Doctoral dissertation). Ghent University, Ghent, Belgium.

* Which datasets in that publication does this sheet apply to?:

All data reported in Chapter 2.

3. Information about the files that have been stored

3a. Raw data

* Have the raw data been stored by the main researcher? ☒ YES / ☐ NO

If NO, please justify:

* On which platform are the raw data stored?

- ☒ researcher PC
- ☒ research group file server
- ☒ other (specify): external data drive

* Who has direct access to the raw data (i.e., without intervention of another person)?

- ☒ main researcher
- ☒ responsible ZAP
- ☐ all members of the research group
- ☐ all members of UGent

- ☐ other (specify):

3b. Other files

* Which other files have been stored?

- ☐ file(s) describing the transition from raw data to reported results. Specify: ...
- ☒ file(s) containing processed data. Specify: SPSS files, RStudio files, Excel files
- ☐ file(s) containing analyses. Specify: ...
- ☐ file(s) containing information about informed consent
- ☐ a file specifying legal and ethical provisions
- ☐ file(s) that describe the content of the stored files and how this content should be

interpreted. Specify: ...

- ☐ other files. Specify: ...

* On which platform are these other files stored?

- ☒ individual PC
- ☐ research group file server
- ☒ other: external data drive

* Who has direct access to these other files (i.e., without intervention of another person)?

- ☒ main researcher
- ☒ responsible ZAP
- ☐ all members of the research group
- ☐ all members of UGent

- ☐ other (specify): ...

4. Reproduction

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* Have the results been reproduced independently?: ☐ YES / ☒ NO

* If yes, by whom (add if multiple):

- name:

- address:

- affiliation:

- e-mail:

Chapter 3

Name/identifier study: PhD Mathias Celis - Chapter 3

Author: Mathias Celis

Date: 18/01/2025

1. Contact details

1a. Main researcher

- name: Mathias Celis
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- e-mail: mathias.celis@ugent.be

1b. Responsible Staff Member (ZAP)

- name: Nicolas Dirix (promotor PhD project)
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If a response is not received when using the above contact details, please send an email to data.pp@ugent.be or contact Data Management, Faculty of Psychology and Educational Sciences, Henri Dunantlaan 2, 9000 Ghent, Belgium.

2. Information about the datasets to which this sheet applies

* Reference of the publication in which the datasets are reported:

Celis, M. (2025). Nudging pension saving decisions. (Doctoral dissertation). Ghent University, Ghent, Belgium.

* Which datasets in that publication does this sheet apply to?:

All data reported in Chapter 3.

3. Information about the files that have been stored

3a. Raw data

* Have the raw data been stored by the main researcher? ☒ YES / ☐ NO

If NO, please justify:

* On which platform are the raw data stored?

- ☒ researcher PC
- ☒ research group file server
- ☒ other (specify): external data drive

* Who has direct access to the raw data (i.e., without intervention of another person)?

- ☒ main researcher
- ☒ responsible ZAP
- ☐ all members of the research group
- ☐ all members of UGent

- ☐ other (specify):

3b. Other files

* Which other files have been stored?

- ☐ file(s) describing the transition from raw data to reported results. Specify: ...
- ☒ file(s) containing processed data. Specify: SPSS files, RStudio files, Excel files
- ☐ file(s) containing analyses. Specify: ...
- ☐ file(s) containing information about informed consent
- ☐ a file specifying legal and ethical provisions
- ☐ file(s) that describe the content of the stored files and how this content should be

interpreted. Specify: ...

- ☐ other files. Specify: ...

* On which platform are these other files stored?

- ☒ individual PC
- ☐ research group file server
- ☒ other: external data drive

* Who has direct access to these other files (i.e., without intervention of another person)?

- ☒ main researcher
- ☒ responsible ZAP
- ☐ all members of the research group
- ☐ all members of UGent

- ☐ other (specify): ...

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* Have the results been reproduced independently?: ☐ YES / ☒ NO

* If yes, by whom (add if multiple):

- name:

- address:

- affiliation:

- e-mail:

Chapter 4

Name/identifier study: PhD Mathias Celis - Chapter 4

Author: Mathias Celis

Date: 18/01/2025

1. Contact details

1a. Main researcher

- name: Mathias Celis
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1b. Responsible Staff Member (ZAP)

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2. Information about the datasets to which this sheet applies

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Celis, M. (2025). Nudging pension saving decisions. (Doctoral dissertation). Ghent University, Ghent, Belgium.

* Which datasets in that publication does this sheet apply to?:

All data reported in Chapter 4.

3. Information about the files that have been stored

3a. Raw data

* Have the raw data been stored by the main researcher? ☒ YES / ☐ NO

If NO, please justify:

* On which platform are the raw data stored?

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- ☒ research group file server
- ☒ other (specify): external data drive

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- ☐ all members of the research group
- ☐ all members of UGent

- ☐ other (specify):

3b. Other files

* Which other files have been stored?

- ☐ file(s) describing the transition from raw data to reported results. Specify: ...
- ☒ file(s) containing processed data. Specify: SPSS files, RStudio files, Excel files
- ☐ file(s) containing analyses. Specify: ...
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- ☒ other: external data drive

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- ☐ all members of UGent

- ☐ other (specify): ...

4. Reproduction

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- address:

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- e-mail:

Chapter 5

Name/identifier study: PhD Mathias Celis - Chapter 5

Author: Mathias Celis

Date: 18/01/2025

1. Contact details

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2. Information about the datasets to which this sheet applies

* Reference of the publication in which the datasets are reported:

Celis, M. (2025). Nudging pension saving decisions. (Doctoral dissertation). Ghent University, Ghent, Belgium.

* Which datasets in that publication does this sheet apply to?:

All data reported in Chapter 5.

3. Information about the files that have been stored

3a. Raw data

* Have the raw data been stored by the main researcher? ☒ YES / ☐ NO

If NO, please justify:

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- ☒ researcher PC
- ☒ research group file server
- ☒ other (specify): external data drive

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- ☐ all members of the research group
- ☐ all members of UGent

- ☐ other (specify):

3b. Other files

* Which other files have been stored?

- ☐ file(s) describing the transition from raw data to reported results. Specify: ...
- ☒ file(s) containing processed data. Specify: SPSS files, RStudio files, Excel files
- ☐ file(s) containing analyses. Specify: ...
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