Journal of Pension Economics and Finance (2025), **24**, 371–391
doi:10.1017/S1474747225000022

ARTICLE

Money-back guarantees in individual retirement accounts: Are they good policy?

Vanya Horneff[1], Daniel Liebler[1], Raimond Maurer[1] and Olivia S. Mitchell[2]

[1]Finance Department, Goethe University, Frankfurt am Main, Germany and [2]Wharton School, University of Pennsylvania, Philadelphia, PA, USA
Corresponding author: Olivia S. Mitchell; Email: mitchelo@wharton.upenn.edu

(Received 17 August 2024; revised 11 January 2025; accepted 24 January 2025; first published online 18 March 2025)

Abstract
Embedding mandatory investment guarantees in individual retirement accounts (IRAs) can protect workers from equity market shortfalls, but policymakers must understand the economic costs of such guarantees as well as their incidence. Using a life cycle model calibrated for Germany, where investors have access to stocks, bonds, and tax-qualified IRAs, we show that abandoning the guarantee could enhance old-age consumption for over 75% of retirees without harming pre-retirement consumption. Investors averse to equity losses accumulate only moderately more in guaranteed accounts, as these offer only limited protection against market crashes.

Keywords: individual retirement account; investment guarantee; life cycle portfolio choice; retirement income

JEL Codes: D14; G20; G11; G51; J26

1. Introduction

Numerous countries have adopted tax-qualified individual retirement accounts (IRAs) as a means to fill the gap between retiree income needs and benefits payable under national social security systems.[1] To encourage participation, policymakers have sought to protect savers against capital losses, with one approach mandating that plan sponsors provide money-back guarantees for participant contributions.

A prominent example and the focus of our study are the German IRAs, known as Riester accounts. Under German law, individuals may contribute to tax-qualified IRAs offered by financial institutions including asset managers, life insurers, and banks as long as these accounts include mandatory embedded money-back guarantees. Such guarantees ensure that savers can recoup all contributions by the end of the accumulation phase.[2] Introduced in 2002, such accounts became very popular, with more than 15 million German workers holding contracts by the end of 2024.

[1]For instance, IRA and defined contribution 401(k) retirement saving plans in the United States now total more than $25 trillion (Investment Company Institute (ICI), 2024). Ernst & Young (2017) reports that individual retirement accounts are available in most European Union countries, though the market is fragmented across member states. Total assets under management amount to €600 billion, of which most, €224 billion, is held by the German Riester IRAs.

[2]The mandatory default option of the Pan-European Personal Pension Product (PEPP) adopted in the European Union (European Commission (EC), 2017; European Parliament (EP), 2019) also requires capital protection, either in the form of a money-back guarantee or another risk mitigation technique. Japanese defined contribution plans are required by law to offer at least one guaranteed account (Allianz Global Investors, nd).

From a policy perspective, mandating retirement account guarantees is often rationalized by arguing that they are conducive to achieving high-priority goals. For example, Célérier and Vallée (2017) showed that catering to household behavioral traits in designing financial products can foster private savings. There is also evidence that many workers are loss-averse, deterring them from saving in the stock market (e.g., Haliassos and Bertaut, 1995; Abdellaoui *et al.*, 2007). Moreover, Calvet *et al.* (2023) reported that providing people access to equity-linked products with a capital guarantee could boost stock market exposures and portfolio returns, especially for loss-averse households.

Investment guarantees can protect workers from equity market shortfalls, yet policymakers must also understand the economic costs and incidence of such guarantees. In the early 21st century, for instance, hedging money-back guarantees would have cost around 5% of annual contributions (Lachance and Mitchell, 2003). However, during the prolonged period of low/near-zero interest rates in European capital markets during the second decade of the 21st century, these guarantee costs would have risen to over 20% of annual contributions. Though interest rates are currently high, the potential return of persistently low or even negative interest rates of the past decade suggests that it is timely to reevaluate pension guarantee products.

It is also important to underscore that taking into account hedging costs alone is not sufficient to quantify the total economic cost of money-back guarantees in IRAs. This is because the cost of hedging is offset by the benefit of reduced downside in falling stock markets. In addition, and more importantly, the interactions with saving and investment decisions outside the IRA as well as the impact on households' consumption opportunities should be included in the analysis.

How such guarantees shape behavior in the context of a life cycle framework is the subject of the present paper. Specifically, we examine how such guarantees can impact consumer old-age security by influencing household economic behavior, and we also explore how behavioral adjustments to their design can affect lifetime welfare.[3] Our analytical framework is a realistically calibrated life cycle model with endogenous consumption, savings, and investment opportunities in risk-free bonds and risky stocks, held inside or outside tax-qualified IRAs. The institutional framework is calibrated to the environment suitable to the German Riester accounts, and it allows for heterogeneous household preferences over consumption, along with additional disutility for losses from risky investments. In this setting, we compare results with and without the money-back guarantees, during both 'normal' and 'low return' environments.

Four main findings emerge from our analysis. First, during 'historically normal' capital market periods, money-back guarantees had only a modest effect on pre-retirement consumption, but they did reduce old-age consumption for about 75% of retirees, by an average of 1.45% per year. This means that eliminating these money-back guarantees would have boosted lifetime utility for a majority of people.

Second, in a low interest environment, the money-back guarantee has a more nuanced impact. On the one hand, the shortfall probability of losing money at age 67 without the guarantee is 9.6%, compared to 2.0% in a 'normal' capital market environment. On the other hand, the costs of protection are so high that 84.3% of retirees would end up with lower old-age consumption, by an average of 5.95% per year.

Third, while eliminating money-back protection can make many retirees better off in terms of lifetime utility, we confirm Calvet *et al.*'s (2023) suggestion that loss-averse households prefer to

[3]Berardi and Tebaldi (2024) also studied the role of return guarantees in IRAs and reach conclusions that are consistent with ours. Nonetheless, their approach uses extensive Monte Carlo simulations to generate return and downside risk profiles of final wealth from different savings plan strategies with fixed contributions. By contrast, we focus on the impact of guaranteed IRA returns on household consumption possibilities, where contributions to retirement accounts are endogenous, and we also include all other sources of retirement financing, such as earned income, social security, and assets outside tax-subsidized retirement accounts.

invest their retirement accounts in equity combined with a money-back guarantee. Nevertheless, the money-back guarantee comes at the cost of reduced old-age consumption, especially in a low interest rate environment.

Fourth, in adverse equity market scenarios, the protection provided by guaranteed IRAs is smaller than many would anticipate. For instance, and perhaps surprisingly, even if the stock market dropped by 35% in workers' final year of employment, most participants would be worse off, compared to not having a guarantee. The reason is that the cost of providing the guarantee erodes the account's asset base, relative to an unprotected scheme.

2. Riester IRAs with money-back guarantees

2.1. Eligibility, incentives, and institutional framework

In 2024, 45 million German employees were entitled to contribute to tax-qualified Riester IRAs, and 15.5 million people held this type of contract (Bundesministerium für Arbeit und Soziales (BMAS), 2024). Workers have three incentives to save for retirement using such accounts. First, the federal government pays a yearly subsidy into each worker's IRA of up to €175 plus €300 per child below age 25. To qualify for the full subsidy, the sum of employee contributions plus subsidies must equal 4% of pre-tax labor income (to a cap of €2,100). Second, employees earning higher incomes can benefit from deferred taxation. The tax authority checks whether the deductibility of contributions from taxable income is more favorable than the subsidy paid, and then it settles any difference through tax refunds. Third, investment earnings on account assets are tax-exempt. In all cases, retirement withdrawals are subject to income tax.[4]

Approximately 65% of Riester contracts are held with life insurers, 20% with asset managers, and 15% with banks; in what follows, we focus on the majority of plans sold by asset managers.[5] Providers of these contracts must abide by investment and income guarantee rules codified in the '*Certification of Retirement Pension Contracts Act*'. Specifically, during the decumulation phase: (1) payouts are allowed only from age 62 onward; (2) not more than 30% of accumulated assets may be withdrawn as a lump sum; (3) the remaining assets must be distributed as lifelong non-decreasing guaranteed nominal benefits; and (4) mandatory annuitization of the retiree's remaining capital is required by age 85 (at the latest). Usually, to fulfill the last requirement, IRA providers use a share of savers' balances at the beginning of the payout phase to buy a deferred annuity paying lifelong benefits starting from age 85.[6] In addition, product providers must offer a money-back guarantee: that is, if at the end of the accumulation phase, the account value is lower than the sum of payments into the IRA, the provider must cover the shortfall.

After strong initial growth of Riester accounts in the German marketplace, the number of contracts has stagnated since 2018. A key reason is that the investment and income guarantees for these IRAs have become more expensive since the scheme was adopted in 2002, when interest rates had fallen from a historical norm of about 3%, down to zero or even negative nominal rates. For example, the price of a deferred annuity purchased at age 67 paying lifelong benefits of €1 from age 85 onward rose from €1.59 (at an interest rate of 3%) to €2.92 (at a 0% interest rate). Another reason is that the low interest environment drove a substantial increase in the costs of providing the money-back guarantee, which we analyze in the following sections.

---

[4]If the participant dies, any remaining IRA assets can be transferred to the spouse's IRA tax-free. It can also be paid out to other heirs, who must, however, repay subsidies and/or tax deductions in addition to inheritance taxes.

[5]Since many life insurance IRAs are unit-linked, the results of our analysis are relevant to that area as well.

[6]This does not necessarily correspond to optimal timing of the deferred annuity purchases (Huang *et al.*, 2016), but it relieves the product provider from holding equity capital to ensure non-decreasing payouts after age 85.

Table 1. Hedging costs of IRA money-back guarantees (as a % of total contributions)

Investment horizon (years)	42	30	20	10
$i_f = 3\%$	4.6	5.3	5.9	6.3
$i_f = 0\%$	25.7	22.0	18.3	13.4

Notes: Table 1 reports, as a % of total contributions, the costs resulting from using fairly-priced put options to hedge the money-back guarantee on contributions. The example assumes constant annual contributions, and the guarantee is provided at the end of the investment horizon. The product provider buys at-the-money put options maturing at retirement to hedge downside risk for each contribution made. Option pricing follows Black and Scholes (1973) with an assumed equity volatility of 15.96% p.a. and interest rates of 3% and 0%.

2.2. Hedging costs of money-back IRA guarantees

From the perspective of the product provider, the money-back guarantee represents a financial risk, since in the event of a shortfall at retirement, the difference between the guaranteed amount and the value of the IRA must be covered from the provider's own funds. To control this risk, the provider must implement hedging strategies, which in turn incur costs that are ultimately passed on the saver. There are various static or dynamic hedging strategies that product providers can use to hedge potential liability from investment guarantees.[7] Here, we consider a put hedge approach, where a portion of the contribution paid by the participant is used to purchase an at-the-money put. While we do not claim that this is the most efficient hedging strategy, it can be integrated into the life cycle model used below with reasonable numerical effort, as it requires only one state variable, unlike most alternatives.

To illustrate the cost of a money-back guarantee, we first consider a simplified IRA that omits optimal choice of annual contributions, as well as the plan's impact on consumption and the demand for liquid savings. We assume constant annual contributions A_t $(t = 1, \ldots, T)$ which are used to buy u_t units of an equity portfolio (represented by a total return stock index) at price S_t, plus the same number of at-the-money European put options at price P_t and maturity at the end of the saving phase, i.e., $A_t = u_t S_t + u_t P_t$. Units of the equity portfolio are allocated to the plan participant's IRA. This produces an uncertain final IRA value at time T of $\max(\sum_{t=1}^{T} u_t S_T, \sum_{t=1}^{T} A_t)$. The put premiums charged by the provider from the participant's contributions are the hedging cost of the money-back guarantee (Lachance and Mitchell, 2003).

To quantify hedging costs and consistent with the life cycle model discussed below, we parameterize that the annual gross stock returns have a volatility of 15.96% per year. Put option premiums are calculated using the Black and Scholes (1973) approach under both a 'normal' interest rate environment ($i_f = 3\%$) and the low interest rate scenario ($i_f = 0\%$). Table 1 summarizes the resulting guarantee costs for various investment horizons.

At a nominal interest rate of 3%, guarantee costs as a share of total contributions average 4.6–6.3%, depending on the plan's investment horizon. At lower interest rates, guarantee costs rise, since the put options become more expensive. For instance, if the interest rate were 0% and the horizon 42 years (coincident with the Riester pension accumulation phase), 25.7% of annual contributions on average would need to be devoted to put options; over a 10-year horizon, the premiums would amount to 13.4% of annual contributions.

3. Money-back guarantees for IRAs in a life cycle model

Considering hedging costs alone is insufficient to quantify the total economic cost of money-back guarantees in IRAs. Instead, one must also examine how such guarantees might affect individuals' investment behavior and consumption opportunities over the life cycle, which requires building and calibrating a discrete-time life cycle model of consumption and portfolio choice. We do so by positing that the utility-maximizing worker decides how much to consume and invest in risky stocks, risk-free

[7] See, for example, Leland (1980), Brennan and Solanki (1981), and Rubinstein and Leland (1981).

bonds, and tax-qualified IRAs. Our framework incorporates the central aspects of the German tax structure, social security system rules, and labor income dynamics.

3.1. Preferences and optimization

Our life cycle model assumes a representative German individual who makes annual decisions from age 24 ($t = 0$) until the maximum age of 100 ($T = 76$). The worker earns uncertain gross labor income Y_t, retires at the regular retirement age of 67 ($t = K = 43$), accumulates assets inside and outside a tax-qualified Riester IRA, and pays taxes as well as social security contributions. Conditional survival probabilities p_t from period t to period $t+1$ are taken from the population mortality table provided by the German Federal Statistical Office. Utility is measured by a time-separable constant relative risk aversion (CRRA) function which is a function of annual consumption C_t, deflated by a consumer price index $\Pi_t = \Pi_{t-1}(1+\pi)$. The price index is assumed to evolve at a constant rate of inflation, π, and Π_0 is normalized to one. Since inflation effectively devalues the IRA's nominal money-back guarantee, the model therefore requires explicit treatment of inflation (see Koijen *et al.*, 2011).[8] The corresponding recursive value function J_t of the certainty equivalent is given by:

$$J_t\left(X_t^R, IRA_t, G_t, D_t, s_t\right) = \max_{C_t,S_t,B_t,A_t,W_{LS}} \left\{ \left(\frac{C_t}{\Pi_t}\right)^{1-\gamma} + \beta p_t E_t\left[J_{t+1}^{1-\gamma}\right] \right\}^{\frac{1}{1-\gamma}}. \tag{1}$$

The value function J_t depends on five state variables (excluding time t): cash on hand, X_t^R (in real terms); the value of the IRA, IRA_t; the guaranteed amount (i.e., the sum of contributions and subsidies), G_t; the annual payout of the deferred annuity after age 85, D_t; and the labor/retirement income state, s_t. Expected lifetime utility is maximized by solving the recursive Bellman equation with respect to consumption, C_t, stock investment, S_t, bond investment, B_t, the IRA contribution, A_t, and IRA lump sum withdrawals W_{LS}. Presuming the common short-sale and borrowing constraints implies non-negativity of all control variables:

$$C_t,\ S_t,\ B_t, A_t, W_{LS} \geq 0. \tag{2}$$

With up to five state variables, this model is computationally expensive to solve. To mitigate the curse of dimensionality, we discretize the labor income process to n_s levels, yielding a considerable reduction in execution time. Transitions between income states are governed by a Markov chain, where $q_{s_t,s_{t+1}}$ denotes the probability of migrating from a current income state s_t to a subsequent period's state s_{t+1} (details appear in Online Appendix A). The expected value function $E_t[J_{t+1}(\cdot)]$ is the probability-weighted average of future value functions given today's income state s_t and transition probabilities $q_{s_t,s_{t+1}}$:

$$E_t\left[J_{t+1}(\cdot)\right] = \sum_s q_{s_t,s} E_t\left[J_{t+1}\left(X_{t+1}^R, IRA_{t+1}, G_{t+1}, D_{t+1}, s_{t+1} = s\right)\right]. \tag{3}$$

We select preference parameters such that the model generates average asset holdings consistent with empirical evidence derived from the Deutsche Bundesbank's Panel on Household Finances (PHF). Specifically, we assume the discount factor $\beta = 0.93$ and the coefficient of relative risk aversion $\gamma = 7$, in line with evidence reported by Dohmen *et al.* (2011) using survey and German Socio-Economic Panel (SOEP) data for German households. In sensitivity analysis, we also extend the utility function to include loss-averse preferences, as in Barberis and Huang (2009).

[8]Our model is solved in a nominal world (i.e., all income figures, tax allowances, etc., grow at the rate of inflation) and the effect of inflation in the intertemporal tradeoff between consuming now and in the future is considered by optimizing real consumption. Results shown below are restated in real terms.

3.2. Budget constraints and evolution of cash on hand

Prior to retirement (at $t = K = 43$), financial resources X_t are allocated to consumption, C_t, investment in stocks, S_t, investment in risk-free bonds, B_t, and IRA contributions, A_t. IRA contributions are unbounded, yet exceeding the amount allowed by the government does not further reduce tax liabilities or increase subsidies. After retirement, additional IRA contributions are not possible, so the budget constraint is:

$$X_t = \begin{cases} C_t + S_t + B_t + A_t & \text{for } t < K \\ C_t + S_t + B_t & \text{for } t \geq K. \end{cases} \quad (4)$$

Next period's cash on hand before, at, and in retirement (after $t = K$) evolves as follows:

$$X_{t+1} = \begin{cases} Y_t(1-h_t)(1-c_t^{SST}) + T_t + S_tR_{t+1} + B_tR_f - CGT_{t+1} & \text{for } t < K \\ (Y_t(1-h_t) + W_{LS})(1-c_t^{SST}) + T_t + S_tR_{t+1} + B_tR_f - CGT_{t+1} & \text{for } t = K \\ (Y_t(1-h_t) + W_t)(1-c_t^{SST}) + S_tR_{t+1} + B_tR_f - CGT_{t+1} & \text{for } K < t \leq K+17 \\ (Y_t(1-h_t) + D)(1-c_t^{SST}) + S_tR_{t+1} + B_tR_f - CGT_{t+1} & \text{for } t \geq K+18. \end{cases} \quad (5)$$

The first component of X_{t+1} is gross income Y_t, either from work or statutory pension benefits after retirement. The stochastic dynamics of labor income are estimated using SOEP data, and pension income reflects the rules of the German social security system (see Online Appendix A for details). Gross income is reduced by federal income taxes and mandatory social security contributions (including unemployment insurance, health benefits, and state pensions), jointly levied as an average deduction rate c_t^{SST}. This formulation reflects the detailed rules and parameters of the German social security system as well as the progressive income tax code (see Online Appendix B for details). The average deduction rate is a function of gross income and whether someone is employed or retired. We apply the rules and parameters as of 2019 to generate values for c_t^{SST} between 10% for retirees with relatively low pension benefits, and 44% for workers with salaries above €150,000. Following Gomes and Michaelides (2005), the resulting net income is further reduced by age-dependent housing costs, h_t, which we estimate from SOEP (details in Online Appendix C).[9] The tax refund T_t results if tax savings due to IRA contributions would be higher than subsidies received.

The next component of cash on hand is the market value of last year's investments in stocks and bonds including returns, $S_tR_{t+1} + B_tR_f$, less taxes on capital gains, CGT_{t+1}. R_{t+1} is the gross return on stocks which is assumed to be log-normally distributed, and R_f is the risk-free return on bonds. Investment income from stocks and bonds is tax-exempt up to an annual limit of €801; over this amount, a capital gains tax rate of 26.375% applies. After retirement, cash on hand includes lump sum withdrawals W_{LS} (at age 67), withdrawals W_t (from age 68 until 84) and constant nominal annuity payouts D from the IRA (from age 85 onward), reduced by income taxes and contributions to health and nursing care insurance.

Each individual is posited to start the work life with a given level of initial wealth, which we assume coincides with the worker's first simulated income level. Levels of starting wealth are estimated from PHF (waves 2 and 3) for individuals age 23–27.[10] In calibrating capital market parameters, we use data from June 1991 to December 2015; all calculations are carried out on a monthly basis and then annualized. All-item consumer prices are taken from Datastream and interest rate data refer to one-year German government bonds taken from Deutsche Bundesbank. As a proxy for the equity market, we obtain euro-denominated MSCI World total return data from Datastream, reflecting the global

[9]Property is the largest component of German household wealth (Deutsche Bundesbank, 2023), yet its purchase is generally accompanied by significant debt financing, violating the non-negativity assumption on asset holdings. For this reason, we do not integrate housing decisions in the model and implicitly treat everyone as tenants. Evidence shows that only 42% of German households live in their own homes.

[10]The values of starting wealth are {€0; €150; €620; €1,600; €2,560; €3,620; €7,160; €12,600; €19,500; €47,300}.

https://doi.org/10.1017/S1474747225000022 Published online by Cambridge University Press

investment focus of fund shares accumulated in Riester accounts. For the 'base case', we use sample means for all variables reflecting what had traditionally been seen as a 'normal' capital market environment. Specifically, the annual inflation rate π is set to 1.75%, close to the European Central Bank's inflation target of '2% inflation over the medium term' (European Central Bank (ECB), 2024).[11] Nominal returns on bonds i_f are set at 3%. The risk premium of the stock index is 5.68% with a volatility of 15.96%. Both estimates are consistent with international and German historical risk premiums (see Jordà *et al.*, 2019).

3.3. Structure of the Riester retirement accounts

During the work life, the employee decides on how much to contribute each period to the IRA, A_t. In addition, the government contributes an amount b_t that includes the basic subsidy of up to €175, plus subsidies of up to €300 per child. We treat the number of children as a deterministic function of age and estimate the count of dependents using SOEP data.[12] Two requirements must be fulfilled to receive the maximum possible government contribution subsidy of $b^{max} = 175 + 300 \cdot n_{children}$. First, the worker must pay in at least €60 of own contributions to receive any IRA subsidy at all (i.e., $A_t \geq 60$). Second, the sum of the worker's own contribution A_t plus the government's subsidy b_t must equal the lesser of 4% of last year's annual gross income Y_{t-1} or €2,100 (formally, $A_t + b_t \geq \min(0.04 \cdot Y_{t-1}, 2100)$). Lower IRA contributions proportionally reduce the subsidies. Consequently, the fraction ($0 \leq \alpha_t \leq 1$) of the maximum attainable subsidy granted is given by ($A_t \geq 60$)

$$\alpha_t = \min\left(\frac{A_t}{\min(0.04 \cdot Y_{t-1}, 2100) - b^{max}}, 1\right) \tag{6}$$

and the resulting subsidy paid into the IRA is $b_t = \alpha_t \cdot b^{max}$.

During the work life, we assume IRA assets are fully invested in stocks, and the product provider purchases at-the-money put options to hedge the money-back guarantee. Put premiums, P_t, directly charged from contributions, are determined using the Black and Scholes (1973) formula. As in Gomes *et al.* (2009), we rule out the possibility of IRA withdrawals before retirement, due to high penalties which render this option unattractive.[13]

IRA contributions cease at the age of 66 ($t = K - 1 = 42$). If the plan balance at retirement has fallen below the worker's lifetime sum of contributions and government subsidies, the product provider must top up the account by paying the difference $\Upsilon = \max\left(\sum_{t=1}^{K-1}(A_t + b_t) - IRA_K, 0\right)$. Subsequently, the saver may elect to withdraw up to 30% of the IRA value as a lump sum, W_{LS}. Moreover, an assumed share of 20% of the pre-withdrawal balance is spent to purchase a deferred annuity that provides lifelong, nominally-fixed benefits of D from age 85 onward. To price the deferred life annuity, we assume the discount rate corresponds to the assumed bond return, apply a population (unisex) mortality table, and add a markup of 12.5% to the respective annuity factor to reflect average loadings in the German private annuity market (Kaschützke and Maurer, 2011).[14]

Annual withdrawals of IRA assets from age 68 to 84 are governed by the formula $W_t = \frac{IRA_t}{85 - age_t}$, which implies that an increasing fraction of the remaining balance is withdrawn, and the account

[11]Modeling stochastic inflation rates is computationally costly, which is why we adopt a deterministic approach. Evidence supports this assumption: the volatility of German inflation rates from 1991 to 2020 remained below 1% p.a.

[12]Receipt of Riester child subsidies is contingent on entitlement to governmental child-care allowances, which are not reported in the SOEP. Instead, we use the number of children living with parents as a proxy. Online Appendix C reports our estimated numbers of children by age.

[13]Early withdrawals trigger a repayment of all granted subsidies and tax allowances (Bundesministerium der Finanzen (BMF), 2019). In addition, front-end loads may be charged as a fraction ζ of total contributions, but in our base case analysis we set $\zeta = 0\%$.

[14]The European Union Directive 2004/113/EC provides that men and women must be treated equally when calculating insurance premiums, so we compute annuity prices based on a unisex mortality table.

is depleted at age 84. The government also requires that benefits during the payout phase may not decrease. Since the provider must make up for shortfalls with its equity capital, the portfolio allocation is shifted to a mix of 20% equities and 80% bonds during the payout phase. Therefore, the evolution of the IRA balance is given by:

$$IRA_t = \begin{cases} IRA_{t-1} \cdot R_t + (A_t + b_t)(1-\zeta) - P_t & \text{for } t < K \\ (IRA_{t-1} \cdot R_t + \Upsilon) \cdot 0.8 - W_{LS} & \text{for } t = K \\ IRA_{t-1} \cdot \left(0.2 \cdot R_t + 0.8 \cdot R_f\right) - W_t & \text{for } K < t \le K + 17 \\ 0 & \text{for } t > K + 17. \end{cases} \quad (7)$$

4. Results for the base case

Next, we use the calibrated life cycle model to examine the implications of switching from the money-back guaranteed IRA to an otherwise identical retirement account without the guarantee. In particular, we show how eliminating the guarantee in the above model alters optimal IRA contributions during the work life, IRA payouts in retirement, liquid asset holdings, and consumption over the life cycle for utility-maximizing individuals with CRRA preferences. Our base case calibration assumes a nominal risk-free rate of 3% and an inflation rate of 1.75%, while the low return scenario posits a 0% interest and inflation rate. These alternatives highlight the protective role of the guarantee as well as its consequences for consumption. Formally, we numerically solve the individual optimization problem outlined in Section 3 by backward induction (see Online Appendix D). Then, using the optimal feedback controls, we generate 100,000 simulated independent life cycles with respect to the exogenous random variables (stock returns, labor income) that form the basis of the subsequent analysis.

4.1. Normal capital market environment

Figure 1 shows how average pre-tax earnings, liquid savings, IRA balances, and payouts evolve in the base case, along with optimal non-housing consumption (all values expressed in €2019) for a money-back guarantee IRA (Panel A) versus an IRA without a guarantee (Panel B).[15] In both scenarios, rising consumption during the first decade of the work life results from the well-known effect of constrained borrowing given rising labor income (Cocco *et al.*, 2005; Chai *et al.*, 2011; Gomes, 2020). Falling consumption during retirement is mainly driven by rising mortality probabilities that reduce the demand for consumption smoothing.

Panel A shows that, at age 67, the IRA with a guarantee is reduced by about €36,400 to €69,900. This is because, first, the product provider expends 20% (€20,700) of the account balance to purchase an annuity with payouts beginning at age 85. Second, the retiree withdraws about 17.7% (€15,700) of the IRA balance as a lump sum at that point. This is well below the allowed maximum of 30%, enabling the retiree to enjoy higher withdrawals later in life. Of this lump sum payout, about one-third (31%) goes to income taxes, and another 61.5% is used to support consumption. The remaining 7.5% is shifted into non-qualified liquid assets which offer greater flexibility in asset allocation and timing of cash flows than the IRA.

At age 68, the retiree's income consists of €15,800 from the social insurance system, €4,100 from IRA withdrawals, and €6,850 from liquidating stocks and bonds. After taxes and social security payments, €4,150 is spent on housing and €17,150 on non-housing consumption. In later periods, consumption smoothing allows the individual to reduce the sale of stocks and bonds when expected IRA payouts increase. At age 85, the IRA payouts consist only of constant nominal annuity payments. By then, the share of income from the social insurance program has risen to 58%, IRA annuity payouts

[15]In the following, we use the terms '*non-housing consumption*' and '*consumption*' interchangeably.

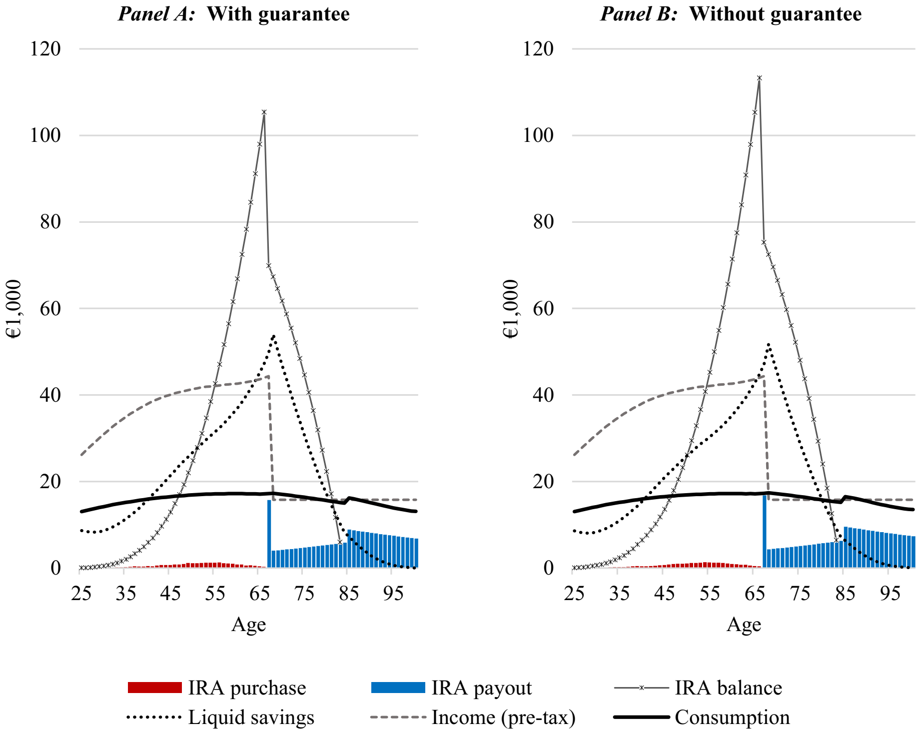

Figure 1. Life cycle profiles with and without IRA guarantee: base case.

Notes: The figure shows mean values of labor and pension income, non-housing consumption, financial assets (bonds, stocks, and IRA balances), and retirement plan payouts (in €2019, left axis). Panel A refers to the base case, where the nominal risk-free rate is 3% and inflation is 1.75%. Stock investments earn a risk premium of 5.68% with volatility of 15.96%. Preference parameters include a discount factor of $\beta = 0.93$ and relative risk aversion of $\gamma = 7$. Panel B is otherwise identical but without a money-back guarantee in the IRA. Mean values are calculated based on 100,000 simulated life cycles which rely on optimal policies derived for all possible combinations of current income, cash on hand, IRA balances, guarantee amounts, and annuity payouts. Prior to retirement at age 67, the IRA is fully invested in equities, from age 67 to 84 the asset allocation consists of 20% stocks and 80% bonds. From age 85 onward, the plan pays out a lifetime annuity. See Section 3 for details.

to 33%, and stock and bond sales only amount to 9%. After age 85, previous consumption levels cannot be maintained due to the devaluation of annuity payouts by inflation and the depletion of liquid assets.

Panel B depicts consumption, income, and asset holding patterns for the no guarantee case. While most of the results are similar, the average IRA balance at retirement is about 7.6% higher without the guarantee (€113,300 versus €105,300 with the guarantee). Greater IRA saving results partly from lower liquid savings: by retirement, these are crowded out by about 5.3% (to only €47,100). Differences in IRA balances can be attributed to hedging costs with a money-back guarantee, as well as to differences in contributions across the two scenarios.

Figure 2 provides a more detailed picture of IRA contribution patterns. Panel A shows the share of individuals contributing to their IRAs, with results mostly comparable under the two scenarios. Starting from low participation rates around 20%, it gradually rises to about 50% by age 40 and further increases to approximately two-thirds by the early sixties. The lower participation rate of the young is driven by relatively low labor incomes and households' need to build up precautionary liquid savings before engaging in illiquid retirement savings. Panel B depicts average IRA contribution rates (including subsidies) as a share of gross income, conditional on participation. Here contribution rates are hump-shaped, rising from 1.0–1.5% in the twenties to peaks of about 5% in the early

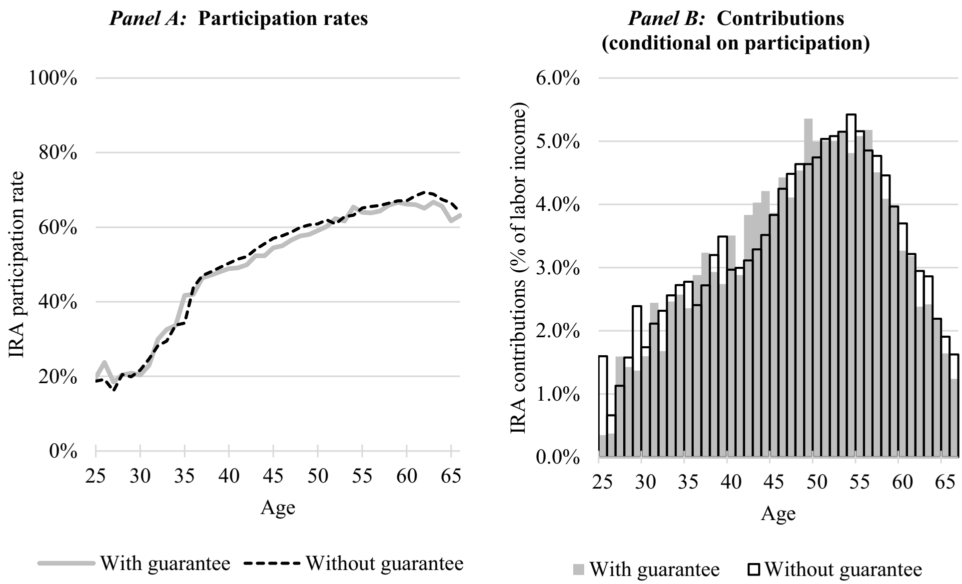

Figure 2. IRA participation rates and plan contributions as a percent of gross labor income by age: base case.
Notes: Panel A shows the fraction of individuals making contributions to an IRA by age under the two alternative scenarios. For additional notes on base case parameters, see Figure 1. Panel B illustrates the pattern of average contributions (including subsidies) to IRAs (conditional on participation) as a percent of gross labor income by age, with and without a money-back guarantee. Results are from 100,000 simulated optimal life cycles.

50s, falling to 1.2–3.6% after age 60. The model-determined falling contribution rates in later life are because the appeal of tax deferral declines as retirement approaches.[16]

Beyond age 60, Panel B shows that participation and contribution rates are systematically higher without the guarantee. Two factors drive this result. First, the cost of purchasing put options becomes more relevant with less time to maturity, leading people to optimally reduce contributions as they near retirement. Second, IRA participants without the guarantee who experience unfavorable returns late in their work lives optimally increase contributions to offset losses. Ultimately, different guarantee costs and payouts, IRA contributions and withdrawals, and portfolio allocations, jointly translate into consumption differences.

The fan chart in the top panel of Figure 3 depicts path-wise percentage consumption differences without versus with the guarantee, where the IRA with a guarantee is the reference point. The turquoise line in the top panel depicts the mean consumption difference, whereas the blue surface illustrates the 5^{th} to 95^{th} percentile, with shading proportional to the distribution mass. The bottom panel reports the share of people having higher consumption in the absence of a guarantee. Overall, mean consumption differences are mostly positive, and the dispersion increases with age. Until age 60, consumption is virtually the same with or without the IRA money-back guarantee. During retirement, however, higher account balances in the no guarantee case result in larger plan withdrawals and annuity payouts that considerably improve old-age consumption. Importantly, consumption is enhanced most when it is at its lowest levels, and the marginal utility of consumption is highest. Put differently, eliminating the guarantee enhances consumption the most, just when unanticipated spending needs might not be met due to low levels of liquid assets and binding borrowing constraints.

[16]The hump-shaped contribution pattern generated by our model is largely in line with actual contribution patterns reported by Dolls *et al.* (2018), though they show contributions peaking around age 45.

https://doi.org/10.1017/S1474747225000022 Published online by Cambridge University Press

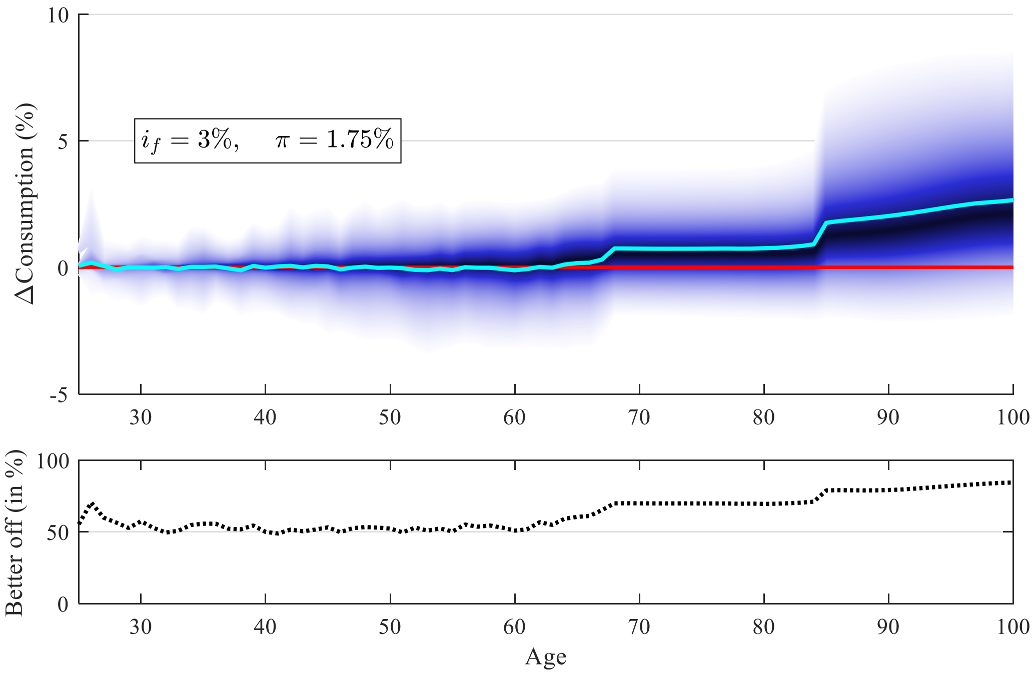

Figure 3. Consumption differences and percentage better off by age without versus with the IRA guarantee: base case.
Notes: The fan chart on the top illustrates path-wise differences in non-housing consumption drawn from 100,000 simulated optimal life cycles for IRAs *without* versus *with* a money-back guarantee. The cyan line represents the mean consumption difference, while darker areas indicate a higher probability density (between the 5 and 95% quantiles). Differences are expressed as a percent of optimal consumption with the money-back guarantee. The bottom panel shows the percentage of individuals having greater optimal consumption *without* versus *with* the money-back guarantee. For further notes on base case parameters see Figure 1.

The bottom panel of Figure 3 shows that most people would be better off if their retirement accounts had no guarantee. In retirement, for instance, two-thirds of all individuals would be better off without the IRA guarantee, and by the end of their lives, this percentage rises to 84.5%. This is because higher withdrawals improve consumption opportunities, and larger annuity payouts supplement social insurance program benefits after liquid assets are depleted. In the top panel, the distribution around the turquoise mean line is fairly symmetric, implying that even those who benefit from the guarantee experience relatively little advantage compared to those without the guarantee. For instance, some of the strongest protection offered by the guarantee occurs at age 67, when consumption for the 5$^{\text{th}}$ percentile would be 2.6% higher for those having seen poor capital market results. At the same age, those having had positive capital market results at the 95$^{\text{th}}$ percentile could boost their consumption by 3.3%, if the IRA had no guarantee. Until the terminal period, the level of protection provided decreases, while excess consumption from abolishing the guarantee rises. For instance, at age 95, those in the 5$^{\text{th}}$ percentile only receive 2.0% more consumption with the guarantee. Conversely, those at the 95$^{\text{th}}$ percentile would expect 8.4% higher consumption if the IRA had no guarantee. In other words, without a guarantee, the upside exceeds the downside in terms of consumption.

Table 2 examines whether the impact of switching to a non-guaranteed IRA on various life cycle outcomes (consumption, liquid savings, IRA balances and payouts) differs by the bottom, middle, and top 10% of lifetime earnings observations. Results are presented as a percentage of the respective guarantee counterfactual.

A key lesson from Panel A is that average consumption is similar in the early years. However, for all three income groups, consumption increases monotonically in the no-guarantee case compared to the

Table 2. Heterogeneity analysis for high, middle, and low income workers: base case

Lifetime income	Top 10%		Middle 10%		Bottom 10%	
Guarantee	With	Without	With	Without	With	Without
***Panel A:* Consumption** (in €1,000 or percent of guarantee case)						
Age 25–45	18.88	100%	15.27	100%	10.65	100%
Age 46–66	27.22	100%	16.29	100%	10.07	100%
Age 67–84	29.53	101%	15.18	101%	7.33	101%
Age 85–100	25.23	102%	13.98	103%	6.53	102%
***Panel B:* Liquid Savings** (in €1,000 or percent of guarantee case)						
Age 25–45	26.32	97%	11.93	97%	3.28	98%
Age 46–66	102.49	98%	22.99	94%	4.80	97%
Age 67–84	80.97	97%	23.26	93%	8.01	96%
Age 85–100	7.78	91%	1.65	85%	0.71	89%
***Panel C:* IRA Balance** (in €1,000 or percent of guarantee case)						
Age 25–45	7.98	108%	3.57	109%	0.36	114%
Age 46–66	116.63	105%	47.22	108%	7.08	108%
Age 67–84	94.29	105%	38.36	109%	5.90	111%
***Panel D:* IRA Payouts** (in €1,000 or percent of guarantee case)						
Age 67: lump sum	31.65	104%	14.86	109%	4.31	110%
Age 68–84: drawdown	10.98	105%	4.47	109%	0.69	110%
Age 85–100: annuity	17.18	105%	7.18	109%	1.29	111%
***Panel E:* Share of Consumption and Housing Costs Financed by IRA Payouts** (%)						
Age 68–84: drawdown	22.6	23.6	18.6	20.0	6.1	6.8
Age 85–100: annuity	39.2	40.6	30.8	32.8	12.1	13.2
***Panel F:* IRA Shortfall Probability** (%)						
Age 67	0.0	0.7	0.0	1.3	0.0	5.4
***Panel G:* Change in Cash on Hand Providing the Same Utility as the Guarantee Case** (%)						
Age 25	–	−0.4	–	−0.3	–	−0.2

Notes: Panels A–D of Table 2 in columns labeled '*With*' show mean values (in €1,000) of annual non-housing consumption, liquid assets, IRA balances, and payouts, by age ranges, for the top 10%, middle 10%, and bottom 10% of lifetime income earners. Columns labeled '*Without*' indicate the percentage of the respective guarantee values. Panel E quantifies the share (in %) of both consumption and housing costs financed by after-tax payouts from the IRA. Panel F reports the share of simulations where the IRA value at retirement falls short of the sum of contributions and subsidies. Panel G presents the percentage change in cash on hand at age 25 for which a switch to the alternative plan design yields the same lifetime utility as the guarantee. IRA assets are held entirely in stocks until retirement (protected with the hedges described above), while after retirement only 20% is allocated to stocks and 80% to bonds. Subgroups are generated using 1,000,000 simulation optimal life cycle paths and summing up individual lifetime labor incomes (all in real terms). For further notes on base case parameters see Figure 1.

guarantee case during the final 15 years of life. These improvements are largest for the middle income earners who can afford considerable IRA contributions; nevertheless, the 2% improvement for low income earners is important given their high marginal utility of consumption. We also find that IRAs without guarantees crowd out liquid savings (Panel B). The reason is that higher average IRA payouts in retirement permit individuals to draw down liquid savings earlier, because the higher annuity payouts help reduce longevity risk. This reduction in liquid assets is most notable for middle earners, who reduce their liquid savings by 7% during early retirement, but increase their IRA balances by a substantial 9% (Panel C). By contrast, workers earning the lowest and the highest incomes reduce their liquid assets by only 4% and 3%, respectively. Overall, low earners can still increase retirement consumption by 1–2% as they boost their IRA balances the most, by 11% in early retirement. The increase in IRA balances is the lowest for high earners at 5%, a group that may be less sensitive to the IRA's guarantee costs due to their higher income and wealth.

Panel D summarizes IRA payouts, and these mirror results from prior panels. For top (middle) earners, non-guaranteed IRA payouts are 4–5% (9%) higher than with guarantees; for low earners, IRA payouts rise by 10–11%. The large improvement for the lowest earners provides only a 1–2% total consumption increase, as their IRA balances and liquid assets are still low.[17] Panel E of Table 2 shows

[17] Bonin (2009) and Börsch-Supan *et al.* (2008) note that low earners may find it unattractive to save in pensions due to high current consumption utility, and tax incentives tend to be weaker for them.

Table 3. Percentage of individuals by age and lifetime income decile having higher consumption without versus with the IRA guarantee: base case

Age	25–45	46–66	67–84	85–100
Top 10%	57	61	67	71
Middle 10%	56	54	72	84
Bottom 10%	45	46	69	80

Notes: This table reports the percentage of individuals having higher non-housing consumption without the money-back guarantee, by age and lifetime income decile. Subgroups are generated using 1,000,000 simulation paths for optimal life cycles, adding up individual lifetime labor incomes (in real terms). The baseline case calibration uses a nominal risk-free rate of 3% and an inflation rate of 1.75%.

that high and middle earners can finance a much higher share of their consumption and housing from IRA payouts than lower-paid workers, with this share generally being higher in the absence of IRA guarantees. Conversely, lower earners benefit more from not being forced into a guarantee, compared to high earners.

Panel F quantifies the downside risk of switching from a guaranteed to a non-guaranteed IRA regime, for each of the three income groups. By construction, in scenarios with money-back guarantees, there is no shortfall risk (defined as having an IRA balance at retirement below the sum of contributions and subsidies). Even without a guarantee, the shortfall probability for high and middle income earners is moderate, at 0.7% and 1.3%, respectively. Yet for low earners, the shortfall probability is much higher, at 5.4%. This difference can be attributed to the fact that low income earners tend to contribute considerably later, around age 56.7 on average, compared to around age 49.8 for high earners and 51.4 for middle earners. Forgoing early contributions implies that low earners build only a small cushion against adverse capital market developments, and therefore they are more vulnerable to losses later in work life. Panel G documents that for top earners, switching to a non-guaranteed IRA would yield the same lifetime utility as the status quo even for a 0.4% reduction in cash on hand at age 25, but the benefit is smaller for middle (0.3%) and low earners (0.2%), due to their lower IRA balances.

Though low earners experience the least additional consumption and are exposed to the greatest increase in shortfall risk without guarantees, Table 3 reveals that this group also has one of the largest proportions benefiting from the absence of the guarantee. Early in retirement (age 67–84), 69% are better off, and 80% later in retirement (age 85–100). The proportions are even higher for middle earners, at 72% and 84%, respectively. Among the highest earners, 67% (71%) enjoy more consumption between age 67–84 (age 85–100).

4.2. Low return capital market environment

Table 4 show the expected life cycle profiles for 0% interest and inflation rates, alongside the baseline capital market scenario. In the low return environment, the impact of the IRA guarantee on consumption becomes more nuanced. In both cases – whether with or without a money-back guarantee – IRA balances (Panel C), payouts (Panel D), and the share of retirement consumption financed by IRA payouts (Panel E) decrease in the zero interest rate regime, relative to the historical 'normal' environment. At the same time, non-tax-qualified liquid savings increase (Panel B). Nevertheless, these higher liquid savings are insufficient to fully compensate for lower IRA payouts, hence old-age consumption (Panel A) declines in the low return scenario. For the guaranteed IRA, consumption in early (late) retirement declines by 7% (19%), but without the guarantee, the decrease is less, at 6% (13%).

Worth noting is that the relative advantage of removing the money-back guarantee is more important in the low interest rate environment. On the one hand, without the guarantee, expected IRA assets available during retirement increase by 85% in the low interest rate environment, much higher than the corresponding 8% increase in the normal capital market scenario. Therefore, IRAs become more

Table 4. Impact of money-back guarantees on average life cycle patterns: normal versus low return scenario

Guarantee	With	Without	With	Without
i_f	3%		0%	
π	1.75%		0%	
***Panel A:* Consumption** (in €1,000 or percent of guarantee case)				
Age 25–45	15.05	100%	14.89	100%
Age 46–66	17.06	100%	16.50	101%
Age 67–84	16.26	101%	15.04	103%
Age 85–100	14.56	102%	11.78	110%
***Panel B:* Liquid Savings** (in €1,000 or percent of guarantee case)				
Age 25–45	12.74	97%	14.45	92%
Age 46–66	33.39	96%	47.90	78%
Age 67–84	30.20	94%	47.82	76%
Age 85–100	2.36	87%	5.12	59%
***Panel C:* IRA Balance** (in €1,000 or percent of guarantee case)				
Age 25–45	3.68	109%	1.20	258%
Age 46–66	51.70	107%	21.69	200%
Age 67–84	42.11	108%	16.27	185%
***Panel D:* IRA Payouts** (in €1,000 or percent of guarantee case)				
Age 67: lump sum	15.74	107%	9.57	148%
Age 68–84: drawdown	4.90	108%	1.86	185%
Age 85–100: annuity	7.83	108%	3.06	176%
***Panel E:* Share of Consumption and Housing Costs Financed by IRA Payouts** (%)				
Age 68–84: drawdown	19.0	20.3	7.7	13.9
Age 85–100: annuity	32.0	33.7	14.9	24.2
***Panel F:* IRA Shortfall Probability** (%)				
Age 67	0.0	2.0	0.0	9.6
***Panel G:* Change in Cash on Hand Providing the Same Utility as the Guarantee Case** (%)				
Age 25	–	−0.3	–	−0.8

Notes: This table shows the average model outcomes for both IRA guarantee types in two economic environments. Columns 1 and 2 consider the ‘normal’ capital market scenario (nominal risk-free rate of 3% and inflation rate of 1.75%) and columns 3 and 4 address the low return environment (nominal risk-free rate and inflation rate of 0%). Other explanations are identical to those in Table 2.

attractive by giving up the guarantee, even though the shortfall probability of losing money at age 67 without the guarantee is 9.6%, compared to 2.0% in the ‘normal’ capital market environment.

In addition, the relative advantage of abolishing the guarantee, in terms of expected old-age consumption, rises from 1–2% in a normal capital market environment to 3–10% in the low interest rate scenario. The improved consumption possibilities are also reflected in the welfare implications of foregoing the money-back guarantee (Panel G). In a normal capital market environment, switching to a non-guaranteed IRA would be beneficial for participants, who would be willing to opt out of the guarantee in exchange for a 0.3% reduction in cash on hand at age 25. In the low return scenario, the percentage is distinctly higher, at 0.8% of cash on hand, corroborating the benefit of eliminating the money-back guarantee while still providing for the same lifetime utility.

Figure 4 provides additional insight into the heterogeneous impacts across individuals if the IRA’s investment guarantee were eliminated. Each of the circles represents a simulated life cycle for the model in the normal (Panel A) and low interest rate scenario (Panel B). The color indicates whether an individual would gain or lose from abolishing the guarantee. Green (purple) circles depict increases (decreases) in retirement consumption, and darker shades reflect larger changes. The horizontal axis shows the average yearly lifetime labor income, while the vertical axis displays the change in IRA contributions expressed as percentage of lifetime labor income if the IRA’s investment guarantee were eliminated.

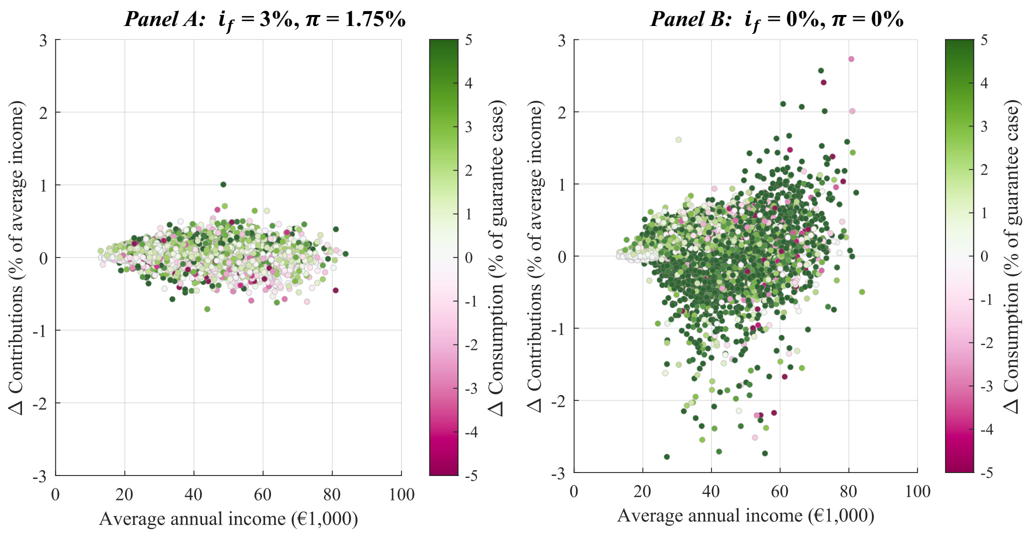

Figure 4. Heterogeneity of impacts of abolishing the IRA guarantee by lifetime income: contributions and old-age consumption.

Notes: This figure illustrates the effect of abolishing the money-back guarantee on total contributions (including subsidies; in percent of average labor income), and average non-housing consumption during retirement, by average lifetime earnings for a normal (Panel A) and a low (Panel B) interest rate and inflation scenario. Changes in consumption are in percent of the guarantee case. Consumption increases (decreases) are indicated by green (purple) circles, and color intensity is stronger for larger changes (white circles indicate tiny changes). Results are shown for the first 10,000 out of 100,000 simulated optimal life cycles. For additional information see Figure 1.

Panel A shows that, under historical interest and inflation rates, 69.3% of participants boost their contributions without the guarantee. Changes are more varied among middle and high earners than low earners. Green circles dominate, indicating that most retirees (74%) experience higher consumption without the guarantee. Low and middle earners benefit the most but also reduce contributions, reallocating resources to liquid savings or work-life consumption.

Several important differences should be noted in the low return environment (Panel B). Old-age consumption rises for most retirees (84.3%) without the guarantee – by an average of 5.9% – indicated by dark green circles which clearly outnumber the dark purple circles. Interestingly, those who benefit substantially from abolishing the guarantee (dark green circles) tend to cut their lifetime contributions, since they achieve desired IRA balances with lower contributions. Among low income earners, consumption improvements are small or very positive, with cases of inferior consumption being rare. At the top of the income distribution, there is notably more heterogeneity in consumption changes, and we observe distinctly more cases of significantly lower consumption without the guarantee.

Overall, this section has shown that the negative implications of money-back guarantee in the low interest rate environment are amplified due to the higher hedging costs.

5. Robustness checks

5.1. *Preferences with loss aversion*

There is evidence that many workers are loss-averse, deterring them from saving and investing in the stock market (e.g., Haliassos and Bertaut, 1995; Schmidt and Traub, 2002; Abdellaoui *et al.*, 2007). Such evidence can also be found, at least in part, for German households participating in Riester accounts (see Online Appendix E). Moreover, protecting savers from losses on accumulated IRA assets has been an important reason that policymakers have justified the money-back guarantee. In this section, we examine this issue by altering the preferences used in the baseline model to reflect savers' aversion to financial losses over and above the usual aversion to consumption fluctuations. Formally, we follow Barberis *et al.* (2001), Barberis and Huang (2009), and Ebner *et al.* (2022), and describe the period-by-period amount of gains and losses resulting from stock investments held inside and outside the IRA with the variable Γ_{t+1}, which affects utility through $v(\Gamma_{t+1})$ only if returns are negative[18]:

$$v(\Gamma_{t+1}) = \begin{cases} 0 & \text{if } R_{t+1} \geq 1 \\ \Gamma_{t+1} & \text{if } \mathrm{R}_{t+1} < 1. \end{cases} \tag{8}$$

The expectation of $v(\Gamma_{t+1})$ enters the value function from Eq. (1), such that:

$$J_t(\cdot) = \max_{C_t, S_t, B_t, A_t, W_{LS}} \left\{ \left(\frac{C_t}{\Pi_t} \right)^{1-\gamma} + \beta [p_t E_t [J_{t+1}] + p_t \Lambda E_t [v(\Gamma_{t+1})]]^{1-\gamma} \right\}^{\frac{1}{1-\gamma}}. \tag{9}$$

Compared to Eq. (1), the added term represents the extra disutility from expected losses in the stock market, with the parameter $\Lambda > 0$ indicating the strength of this component of the utility function relative to that from consumption.[19] For comparability with the previous results, we choose the same parameters for relative risk aversion $\gamma = 7$ and the time discount factor $\beta = 0.93$. The loss framing parameter is set to $\Lambda = 0.006$, which aligns with empirical studies on loss aversion (see Abdellaoui *et al.*, 2007; Dimmock and Kouwenberg, 2010). Next, using these preferences and our other initial parameterizations, we re-solve the life cycle model. Table 5 reports the results for financially loss-averse participants.

Compared to standard preferences in a normal interest rate and inflation scenario (Table 4), loss-averse individuals increase their IRA holdings (by 1% in the second part of the work life, and by 5% in early retirement) because they value the protection offered by the money-back guarantee. At the same time, they adjust liquid asset holdings (by +2% in the late work life, and by −10% in early retirement), reducing their equity allocation to mitigate the impact of losses on utility. Overall, the more cautious investment behavior of the loss-averse results in moderately lower old-age consumption (by at most 0.5%), compared to standard preferences. In a low interest rate scenario, the shifts from liquid assets (−10% in the work life and −15% in early retirement) to IRAs (around +28%) by loss-averse households relative to CRRA savers are even more pronounced, but the impact on old-age consumption remains small (±1%).

Eliminating the money-back guarantee in the normal interest rate scenario reduces IRA holdings for the financially loss-averse (by 25% late in the work life and 18% in early retirement), increases their holdings of liquid assets (by 23% late in the work life, and 7% in early retirement), further reduces their already low liquid stock share (by about 15–20%), and yields 3–8% lower consumption in old age. Yet the utility impact is very moderate: the loss-averse would demand only 0.2% more cash on hand at age 25 to give up the guarantee, whereas those with standard preferences would be willing to give up 0.3% of their cash to abandon the guarantee. In summary, in the normal interest rate scenario, the attractiveness of the money-back guarantee in IRAs increase for financially loss-averse savers, as opposed to CRRA savers.

A different result is evident in the low interest rate scenario. Removing the guarantee for the loss-averse increases IRA holdings by about two-thirds, relative to the guarantee case, highlighting that

[18] Online Appendix F presents the calculation of Γ_{t+1} in detail, taking into account that the money-back guarantee does not take effect every year, but only at the end of the accumulation period.

[19] This differs from Barberis and Huang (2009), who consider both expected gains and losses in the utility function $E_t[v(\Gamma_{t+1})] = b_0 E_t[\max(\Gamma_{t+1}, 0) + \lambda \min(\Gamma_{t+1}, 0)]$; hence they use two parameters, a narrow framing b_0 and a loss aversion coefficient λ, to capture loss-averse preferences. Here, we follow Ebner *et al.* (2022) who include only expected losses $E_t[v(\Gamma_{t+1})] = \Lambda E_t[\min(\Gamma_{t+1}, 0)]$ and derive for lognormally distributed returns an analytical formula relating the loss framing parameter Λ directly to the Barberis and Huang (2009) two-parameter (b_0, λ)-approach. For our parameters on stock returns, $\Lambda = 0.006$ corresponds to $\lambda = 4.21$ and $b_0 = 0.7$.

Table 5. Model results under loss aversion preferences

Guarantee	With	Without	With	Without
i_f	3%		0%	
π	1.75%		0%	
***Panel A:* Consumption** (in €1,000 or percent of guarantee case)				
Age 25–45	15.00	100%	14.88	100%
Age 46–66	16.90	100%	16.35	101%
Age 67–84	16.18	98%	14.92	102%
Age 85–100	14.56	94%	11.95	105%
***Panel B:* Liquid Savings** (in €1,000 or percent of guarantee case)				
Age 25–45	12.98	110%	13.79	99%
Age 46–66	33.97	116%	43.17	97%
Age 67–84	27.28	112%	40.74	90%
Age 85–100	1.62	110%	3.46	76%
***Panel C:* IRA Balance** (in €1,000 or percent of guarantee case)				
Age 25–45	3.74	52%	1.81	145%
Age 46–66	52.43	79%	27.92	130%
Age 67–84	44.37	83%	20.58	130%
***Panel D:* IRA Payouts** (in €1,000 or percent of guarantee case)				
Age 67: lump sum	14.95	82%	10.58	118%
Age 68–84: drawdown	5.17	83%	2.36	130%
Age 85–100: annuity	8.10	83%	3.74	128%
***Panel E:* Share of Consumption and Housing Costs Financed by IRA Payouts** (%)				
Age 68–84: drawdown	20.1	17.1	9.9	12.6
Age 85–100: annuity	33.0	28.9	18.0	22.2
***Panel F:* IRA Shortfall Probability** (%)				
Age 67	0.0	2.6	0.0	9.8
***Panel G:* Change in Cash on Hand Providing the Same Utility as the Guarantee Case** (%)				
Age 25	–	+0.2	–	−0.1

Notes: This table shows the model outcomes for both IRA guarantee types and economic environments if employees are loss-averse and optimize utility according to Eq. (9). We assume $\Lambda = 0.006$. Because the money-back guarantee is only tested once at retirement, approximations for intra-period loss penalties are required during the accumulation phase. For the IRA with the guarantee, we assume that losses are only subject to penalties as long as the IRA balance exceeds the guarantee amount. After retirement, when participants are no longer protected by guarantees, regular penalties apply. Losses in liquid equity investments and in IRAs without guarantees are always fully penalized. Other explanations are identical to those in Tables 2 and 4.

high guarantee costs reduce the benefits of downside protection. As for CRRA savers, eliminating the guarantee enhances lifetime utility for loss-averse households. Consumption in retirement is higher than with the guarantee (by 2–5%), and loss-averse investors would be willing to give up 0.1% of their age-25 cash-on-hand to opt out of the guarantee.

In summary, while the guarantee is conceptually appealing to financially loss-averse workers because it provides downside protection for risky stock investments, in practice its costs can offset this advantage. Because the money-back guarantee only protects against losses below the guarantee amount and leaves balances above that amount unprotected, its costs can be too high to make the money-back guarantee worthwhile, even for loss-averse savers.

5.2. Resilience to capital market crashes

Policymakers intended that IRA guarantees would provide savers with downside protection against adverse capital market developments, yet as we have shown, this comes at the cost of lower average payouts. Indeed, our results show that guarantees erode consumption, and downside protection appears surprisingly small. Nevertheless, since savers choosing guaranteed IRAs seem to value the promised protection, we next quantify how well such IRAs might perform if a severe shock were to hit the equity market at the end of the accumulation phase. Specifically, we examine a scenario where

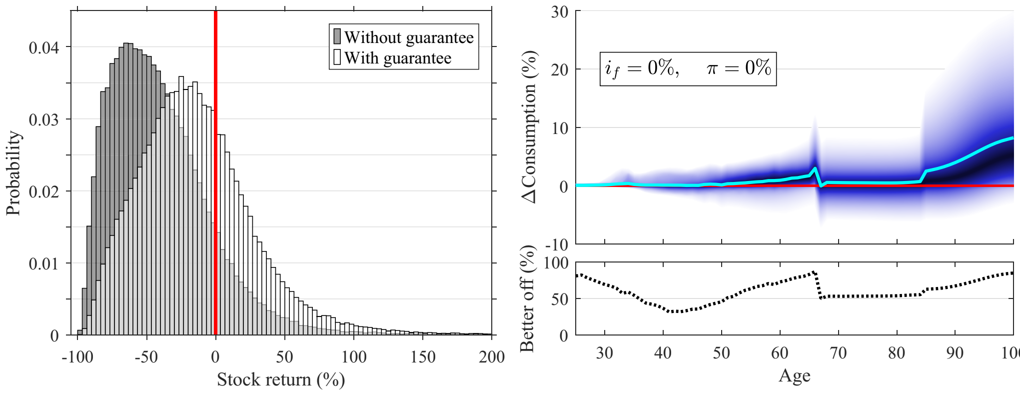

Figure 5. Impact of an equity market crash on consumption in the low interest rate scenario.
Notes: The figure considers the performance of schemes *with* a money-back guarantee and *without* a guarantee, given that an unanticipated equity market crash of −35% happens in the period before retirement. The histogram on the left illustrates the frequency of the *distance to guarantee payoff*, which is the last work period's return in the equity market that would equate the IRA balance at retirement to the guarantee amount. The fan chart on the top right illustrates path-wise differences in non-housing consumption drawn from 100,000 simulated optimal life cycles for IRAs *without* versus *with* a money-back guarantee. The bottom right panel shows the percentage of individuals having greater optimal consumption *without* versus *with* the money-back guarantee. All remaining explanations are analogous to those of Figure 3.

the equity market unexpectedly plummets by 35% immediately before retirement, in the low interest rate environment.[20] The histogram in Figure 5 displays the *distance to guarantee payoff* for the cases with and without a money-back IRA. This metric quantifies how big the equity return in the last working period would need to be, such that at retirement, the IRA balance exactly matched the sum of contributions and subsidies (the *guarantee amount*).

In the left panel, the light (dark) bars show the frequency distribution of the distance to the guaranteed payoff, for an IRA with (without) a money-back guarantee. This is measured one year from retirement, in all cases.[21] The vertical line splits the data into accounts in surplus above the guaranteed amount (left of the line), and those in deficit (right of the line). With the guarantee, 32.1% of the IRA balances fall short one year before retirement, whereas without the guarantee, only 12.4% of the accounts are in shortfall. Meanwhile, in the no-guarantee scenario, the probability mass is much more concentrated in the left tail, where also accounts deep in surplus are found. These have accumulated large cushions over the guarantee amount, allowing them to withstand even unusually large equity market crashes before balances fall below the guarantee amount. Significantly smaller cushions are evident for the money-back guaranteed IRA, attributed to the costs of providing the guarantee. These expenses constitute a drag on investable capital, increasing the likelihood that the balance ultimately falls short of the guarantee amount.

The fan chart in the right panel of Figure 5 illustrates path-wise consumption differences between the IRA with versus without a guarantee, when the equity market unexpectedly drops by 35% a year before retirement. Even after such a severe equity market crash, average retiree consumption without the guarantee would be about 1–8% higher, and 53–85% of the savers could consume more. Naturally, this comes at the cost of tolerating inferior downside measures for part of the return distribution. Yet even the least fortunate 5% of the distribution would not experience disastrous consumption losses (though losing 3–6% of retiree consumption is considerable). Still, it may be surprising to many that the IRA guarantee does not strictly dominate, even in this rare market crash scenario.

[20]This roughly corresponds to the drop in the stock market after the outbreak of the Coronavirus in early 2020. This also aligns with the 3.9th percentile of the 12-month rolling returns from 06/1990 until 06/2024.

[21]Here, we focus only on losses during the last work period, because there is no chance that the balance can recover before the money-back guarantee is tested.

6. Conclusions

This study illustrates how money-back guarantees in individual retirement accounts alter lifetime consumption opportunities and portfolio decisions, when individuals who maximize their lifetime utility have access to stocks, bonds, and IRAs. In addition, we consider how loss-averse investors evaluate mandated guarantees similar to those embedded in the German Riester plans.[22] We show that eliminating money-back protection can enhance old-age consumption for many retirees, because removing the guarantee saves the cost of providing it, and then that money can be invested for the benefit of the saver. In a 'normal' capital market environment, such a guarantee could have been seen as a reasonable way to protect workers from investment losses in their IRAs. Yet if interest rates again become zero or negative, as they were in the past decade, these guarantee costs would cause unintended harm by eroding old-age consumption below what it would have been otherwise. Moreover, even if the stock market crashed right before retirement, most people would still be better off without the guarantee.

Of course, our analysis cannot lead us to conclude that IRA money-back guarantees are *never* beneficial: that is, for no investor and in no capital market situation. Yet our richly calibrated and variant-rich life cycle model demonstrates that, from an *ex-ante* perspective, this holds true for most people having different income profiles, preferences, and across both typical and atypical market scenarios (such as a prolonged zero-interest rate environment like in Europe). Therefore, we conclude that a legally mandated money-back guarantee as currently required in German IRAs, as well as in Pan-European Pension Products (PEPP), provides more drawbacks than benefits.

Our findings are relevant to policymakers, regulators, and plan sponsors globally, insofar as many countries are responding to the challenges of population aging by implementing tax-qualified IRAs. These include the U.S. 401(k) model, the European PEPP, and defined contribution plans in Australia, Hong Kong, and Chile, along with many others. Of key importance in such funded pension systems is the appropriate design of default investment options which, on the one hand, protect savers from downside risks, while on the other hand, preserve savers' opportunity to access equity markets. In particular, regulators will benefit from a clearer understanding of the costs and benefits associated with money-back guarantees, as well as other risk mitigation techniques.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S1474747225000022.

Acknowledgements. The authors are grateful for research support from the German Investment and Asset Management Association (BVI), the Leibniz Institute for Financial Research SAFE funded by the State of Hessen, and the Pension Research Council/Boettner Center at The Wharton School of the University of Pennsylvania. We thank the Competence Center for High Performance Computing in Hessen for granting us computing time on the Goethe-HLR and Lichtenberg Cluster. Data were generously provided by the German Socio-Economic Panel and the Deutsche Bundesbank Panel on Household Finances. Opinions and any errors are solely those of the authors and not of the institutions with which the authors are affiliated nor any individual cited.

References

Abdellaoui M, Bleichrodt H and Paraschiv C (2007) Loss aversion under prospect theory: A parameter-free measurement. *Management Science* **53**(10), 1659–1674.

Allianz Global Investors (nd) *Pension System in Japan (Pension Funds Online)*. https://www.pensionfundsonline.co.uk/content/country-profiles/japan/103 (accessed 6 January 2025).

[22]In the online appendices G to L we provide further robustness tests, which support the main conclusion of the analysis presented in the main text. Online Appendix G shows results for life cycle funds as an alternative risk mitigation approach. Online Appendix H shows results to Epstein and Zin (1989) preferences (for $\psi \neq 1/\gamma$), and to the inclusion of front-end loads on contributions. Online Appendix I extends the analyses on loss aversion for life cycle funds. Online Appendix J presents an alternative mechanism to hedge the money-back guarantee as well as the implications for plan participants. Online Appendix K changes the assumption on equity market parameters.

Barberis N and Huang M (2009) Preferences with frames: A new utility specification that allows for the framing of risks. *Journal of Economic Dynamics and Control* **33**(8), 1555–1576.

Barberis N, Huang M and Santos T (2001) Prospect theory and asset prices. *Quarterly Journal of Economics* **116**(1), 1–53.

Berardi A and Tebaldi C (2024) Saving for retirement in Europe: The long-term risk-return tradeoff. *Journal of Pension Economics and Finance* **23**(2), 272–293.

Black F and Scholes M (1973) The pricing of options and corporate liabilities. *Journal of Political Economy* **81**(3), 637–654.

Bonin H (2009) 15 years of pension reform in Germany: Old successes and new threats. *Geneva Papers on Risk and Insurance* **34**(4), 548–560.

Börsch-Supan A, Reil-Held A and Schunk D (2008) Saving incentives, old-age provision and displacement effects: Evidence from the recent German pension reform. *Journal of Pension Economics and Finance* **7**(3), 295–319.

Brennan MJ and Solanki R (1981) Optimal portfolio insurance. *The Journal of Financial and Quantitative Analysis* **16**(3), 279–300.

Bundesministerium der Finanzen (BMF) (2019) *Statistik zur Riester-Förderung*. https://www.bundesfinanzministerium.de/Content/DE/Standardartikel/Themen/Steuern/Steuerliche_Themengebiete/Altersvorsorge/2019-11-15-Statistische-Auswertungen-Riester-Foerderung-bis-2018.html (accessed 15 December 2020).

Bundesministerium für Arbeit und Soziales (BMAS) (2024) Entwicklung der Riester-Verträge. https://www.bmas.de/SharedDocs/Downloads/DE/Rente/entwicklung-riester-vertraege.pdf (accessed 3 July 2024).

Calvet LE, Célérier C, Sodini P and Vallée B (2023) Can security design foster household risk-taking? *The Journal of Finance* **78**(4), 1917–1966.

Célérier C and Vallée B (2017) Catering to investors through security design: Headline rate and complexity. *Quarterly Journal of Economics* **132**(3), 1469–1508.

Chai J, Horneff W, Maurer R and Mitchell OS (2011) Optimal portfolio choice over the life cycle with flexible work, endogenous retirement, and lifetime payouts. *Review of Finance* **15**(4), 875–907.

Cocco JF, Gomes FJ and Maenhout PJ (2005) Consumption and portfolio choice over the life cycle. *Review of Financial Studies* **18**(2), 491–533.

Deutsche Bundesbank (2023) *Monatsbericht April 2023*. https://www.bundesbank.de/resource/blob/908138/5fa52fcaa9ad19972391d3c8c1bb82ce/mL/2023-04-vermoegensbefragung-data.pdf (accessed 23 May 2024).

Dimmock SG and Kouwenberg R (2010) Loss-aversion and household portfolio choice. *Journal of Empirical Finance* **17**(3), 441–459.

Dohmen T, Falk A, Huffman D, Sunde U, Schupp J and Wagner GG (2011) Individual risk attitudes: Measurement, determinants, and behavioral consequences. *Journal of the European Economic Association* **9**(3), 522–550.

Dolls M, Doerrenberg P, Peichl A and Stichnoth H (2018) Do retirement savings increase in response to information about retirement and expected pensions? *Journal of Public Economics* **158**, 168–179.

Ebner A, Horneff V and Maurer R (2022) Life-cycle portfolio choice with stock market loss framing: Explaining the empirical evidence. *Pension Research Council Working Paper 2022-02*.

Epstein LG and Zin SE (1989) Substitution, risk aversion, and the temporal behavior of consumption and asset returns: A theoretical framework. *Econometrica* **57**(4), 937–969.

Ernst & Young (2017) *Study on the Feasibility of a European Personal Pension Framework*. https://ec.europa.eu/info/sites/info/files/170629-personal-pensions-study_en.pdf (accessed 9 October 2019).

European Central Bank (ECB) (2024) *Two Per Cent Inflation Target*. https://www.ecb.europa.eu/mopo/strategy/pricestab/html/index.en.html (accessed 17 August 2024).

European Commission (EC) (2017) *Proposal for a Regulation of the European Parliament and of the Council on a Pan-European Personal Pension Product (PEPP)*. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52017PC0343&from=EN (accessed 8 September 2017).

European Parliament (EP) (2019) *Regulation (EU) 2019/1238 of the European Parliament and Council of 20 June 2019 on a pan-European Personal Pension Product (PEPP)*. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R1238 (accessed 28 April 2020).

Gomes FJ (2020) Portfolio choice over the life cycle: A survey. *Annual Review of Financial Economics* **12**, 277–304.

Gomes FJ and Michaelides A (2005) Optimal life-cycle asset allocation: Understanding the empirical evidence. *The Journal of Finance* **60**(2), 869–904.

Gomes FJ, Michaelides A and Polkovnichenko V (2009) Optimal savings with taxable and tax-deferred accounts. *Review of Economic Dynamics* **12**(4), 718–735.

Haliassos M and Bertaut CC (1995) Why do so few hold stocks? *The Economic Journal* **105**(432), 1110–1129.

Huang H, Milevsky MA and Young VR (2016) Optimal purchasing of deferred income annuities when payout yields are mean-reverting. *Review of Finance* **21**(1), 327–361.

Investment Company Institute (ICI) (2024) *Quarterly Retirement Market Data, First Quarter of 2024*. https://www.ici.org/statistical-report/ret_24_q1 (accessed 17 June 2024).

Jordà Ò, Knoll K, Kuvshinov D, Schularick M and Taylor AM (2019) The rate of return on everything, 1870–2015. *Quarterly Journal of Economics* **134**(3), 1225–1298.

Kaschützke B and Maurer R (2011) The Private Life Annuity Market in Germany: Products and Money's Worth Ratios. In Mitchell O. S., Piggott J. and Takayama N. (eds). *Securing Lifelong Retirement Income*. Oxford: Oxford University Press, 131–158.

Koijen RSJ, Nijman TE and Werker BJM (2011) Optimal annuity risk management. *Review of Finance* **15**(4), 799–833.

Lachance M-E and Mitchell OS (2003) Guaranteeing individual accounts. *American Economic Review P&P* **93**(2), 257–260.

Leland HE (1980) Who should buy portfolio insurance? *The Journal of Finance* **35**(2), 581–594.

Rubinstein M and Leland HE (1981) Replicating options with positions in stock and cash. *Financial Analysts Journal* **37**(4), 63–72.

Schmidt U and Traub S (2002) An experimental test of loss aversion. *Journal of Risk and Uncertainty* **25**(3), 233–249.

Cite this article: Horneff V, Liebler D, Maurer R and Mitchell OS (2025) Money-back guarantees in individual retirement accounts: Are they good policy? *Journal of Pension Economics and Finance* **24**(3), 371–391. https://doi.org/10.1017/S1474747225000022