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Investing for Retirement with an Explicit Benchmark

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Abstract

Defined contribution (DC) pension schemes expose their participants to a significant amount of uncertainty regarding their pension capital at retirement. Traditional life-cycle investment strategies are based on maximizing the return of the investment portfolio based on a utility function with constant relative risk-aversion (CRRA). We explore the impact of using a different utility specification, where we assume that participants assess utility relative to a benchmark at retirement and that the utility function has a non-constant relative risk-aversion. Due to this alternative utility specification, we obtain investment strategies that explicitly attempt to attain the benchmark at retirement. As a result, the uncertainty of the pension capital relative to the benchmark is reduced significantly compared to traditional life-cycle investment strategies.

Samenvatting

Pensioenregelingen op basis van beschikbare premie (defined contribution, DC) stellen hun deelnemers bloot aan grote onzekerheid aangaande het pensioenvermogen bij pensionering. Traditionele strategieën op basis van beleggingen over de levensloop hebben als doel het maximaliseren van het rendement van de beleggingsportefeuille op basis van een nutsfunctie met constante relatieve risicoaversie (CRRA). We onderzoeken de invloed van het gebruik van een andere specificatie van de nutsfunctie, met de aanname dat deelnemers hun nut beoordelen ten opzichte van een benchmark bij pensionering plus dat de nutsfunctie een niet-constante relatieve risicoaversie kent. Vanwege deze alternatieve nuts-specificatie verkrijgen we beleggingsstrategieën die expliciet proberen om de benchmark te halen bij pensionering. Hierdoor wordt de onzekerheid van het pensioenvermogen ten opzichte van de benchmark aanmerkelijk verkleind vergeleken met traditionele life-cycle investeringsstrategieën.

1 Introduction

The “new Dutch pension deal”, which was negotiated between the social partners in the Netherlands in the summer of 2020, signifies a further step towards defined contribution (DC) plans and a related shift away from defined benefit (DB) plans. The associated transfer of investment risk, from the employer to the employee, leaves the participants with greater uncertainty regarding the amount of their retirement capital. The social partners in the Netherlands are currently investigating various forms of buffering, in an attempt to share the investment uncertainty between different generations. A potential problem with intergenerational risk sharing is that it may lead to tensions between the various generations, especially after an extended period of low market returns (see, e.g., Werker, 2017).

In this paper, we explore a different approach to addressing the uncertainty for participants regarding their retirement capital. In an attempt that preserves some of the beneficial features of DB plans within a DC scheme, we investigate the situation where the participant’s preferences explicitly include a stochastic benchmark at retirement. Such a benchmark can be driven by the desire to maintain a standard of living after retirement that corresponds with the income earned before retirement. This approach implies dynamic investment strategies that explicitly try to attain the desired benchmark capital at retirement. We illustrate and investigate the resulting optimal investment strategies and then compare the outcome with a standard Merton-type life-cycle investment strategy. We show that a benchmark-based investment strategy significantly increases the probability that the participant will obtain a retirement capital near the desired benchmark. As a result, the uncertainty for participants of the pension capital relative to the benchmark is reduced significantly compared to traditional life-cycle investment strategies.

This paper makes a contribution to the literature on optimal investment problems where investors seek to outperform a pre-determined benchmark. The literature in this area can be divided along two lines. The first line adds an extra constraint to the utility maximization framework, which states that terminal capital should exceed a specific (potentially stochastic) benchmark. Typically, this way of modelling the investor-specific preferences with regard to a benchmark is referred to as *portfolio insurance*, see e.g. Basak (1995), Tepla (2001), Basak et al. (2006), Basak and Chabakauri (2012), and Browne (2013). Even though the constraint ensures that one ends up with at least the preferred amount of capital at retirement, the addition of a hard constraint has a drawback: it can not cope with underfunding situations. In Tepla (2001) and Basak and Shapiro (2001) the authors must postulate that the present value of the benchmark does not exceed a prespecified value. Unfortunately, the pension industry currently faces widespread underfunding, which makes this approach to the problem less attractive.

The second line of literature models the preferences pertaining to the benchmark by explicitly incorporating the benchmark in the utility function. Examples of this approach can be found in Brennan and Xia (2002), Berkelaar et al. (2004), Basak et al. (2008), Bali et al. (2009), and Shen et al. (2019). Unlike the portfolio insurance setups, including a benchmark within the utility function enables one to deal with under-funding. Obviously, the hard guarantee of attaining the benchmark must be relaxed in this case. Our contribution to this line of the literature consists of using a utility function with a non-constant risk-aversion parameter.

In our model setup, we assume that participants convert their pension capital at retirement date T into an annuity to finance their consumption after retirement. Furthermore, we assume that the participants relate their consumption after retirement to the “standard of living” acquired during their working life, plus we assume that they can maintain their standard of living by buying an annuity at time T linked to their level of income at time T. Hence, our stochastic benchmark is the value of this annuity at time T. For our utility specification, we assume that participants look at the ratio of pension capital at time T and the value of the benchmark. We call this ratio the *replacement ratio*, and we assume that the participants wish to attain a replacement ratio close to 100%. We incorporate this wish into our utility function by constructing a utility function that has a different level of risk-aversion for a replacement ratio below or above 100%. This utility specification gives rise to dynamic investment strategies that switch between risky and safe investment strategies, where the switching is triggered by the expectation (state- and time-dependent) of achieving a replacement ratio above or below 100% at retirement. We show that these dynamic investment strategies can significantly improve the probability of attaining replacement ratios of 90% or 100% at the retirement date, even when the participant starts from an initially underfunded position. As a result, the uncertainty regarding the pension capital relative to the benchmark is reduced significantly compared to traditional life-cycle investment strategies.

The rest of this paper is organized as follows. In Section 2, we describe the financial model. As we want to focus on the main concepts and want to avoid technicalities, we use a standard Black-Scholes model for the financial market. In Section 3, we briefly recap the results for optimal investment with a power utility without any explicit benchmark. In Section 4, we study the impact of using a power utility function with an explicit benchmark, and we show that this leads to different optimal investment strategies. In Section 5 we introduce our double-power utility function and show how this influences the probability of attaining the benchmark at retirement. Section 6 contains our conclusions.

2 Financial Market Model and Wage Income

In this section we present our model for the financial market and the wage-income of pension participants. For ease of understanding, we will present a highly stylized model. This will help us to highlight the most important features of the different investment strategies.

Our basic financial model is a Black-Scholes type model, where a stock-market index S_t follows a geometric Brownian Motion:

$$dS_t = \mu S_t\, dt + \sigma S_t\, dW_t. \tag{2.1}$$

We assume that the expected return μ and the volatility σ of the stock-market are constants. We also assume that the risk-free interest rate is equal to 0.[1]

As we are interested in modelling a life-time investment strategy for pension participant during their working life until retirement, we also model the wage-income of the pension participant. To capture the uncertainty in future wages, we make the simplifying modelling assumption that changes in wages are perfectly correlated to changes in the stock price.

In the sections below, we will introduce the *pricing kernel* Q_T. The pricing kernel is used to compute the prices of assets in the economy. In the Black-Scholes-type model the pricing kernel process is given by:

$$Q_T = \exp\left\{-\tfrac{1}{2}\lambda^2 T - \lambda W_T\right\} \quad \text{with} \quad \lambda := \tfrac{\mu}{\sigma}, \tag{2.2}$$

where λ denotes the market price of risk. Computing prices by means of the pricing kernel is equivalent to using a "risk-neutral" expectation $\mathbb{E}^{\mathbb{Q}}[]$ to compute prices. Hence, the price X_0 at time 0 of an asset with a payoff X_T at time T can be computed in two equivalent ways as

$$X_0 = \mathbb{E}[Q_T X_T] = \mathbb{E}^{\mathbb{Q}}[X_T], \tag{2.3}$$

where $\mathbb{E}^{\mathbb{Q}}[]$ denotes the "risk-neutral" expectation.

Suppose that during working life, an employee pays a fixed fraction $0 < \phi < 1$ of his or her wages as a contribution into the employee's pension fund. The value X_0 at $t = 0$ of this stream of contributions can be computed as follows:

$$X_0 = \mathbb{E}^{\mathbb{Q}}\left[\int_0^T \phi w_t\, dt\right] = \int_0^T \phi\, \mathbb{E}^{\mathbb{Q}}[w_t]\; dt. \tag{2.4}$$

[1]Alternatively, we can say that all financial variables that we consider are already discounted by applying the risk-free interest rate.

We normalize the initial wage to $w_0 = 1$. To introduce uncertainty about future wages, we assume that wages grow at the same rate as stock prices[2]. Hence, $w_t = w_0 \left(S_t/S_0\right)$ and we get $\mathbb{E}^{\mathbb{Q}}\left[w_t\right] = w_0 = 1$ for all t. Hence, we can express the present value of the stream of contributions over the entire working career as $X_0 = \phi T$.

[2]This is a simplifying assumption, which we make for ease of exposition. In a more realistic setting, we would need to introduce extra sources of uncertainty such as price- and wage-inflation. The qualitative results that we obtain in the current simplified setting also hold for more complex models (see, e.g. Kamma and Pelsser, 2019).

3 Merton-type Investment Strategy

In this section we briefly recap the life-time investment strategy for a pension participant with power-utility for the capital at retirement. This is our base case, where we do not take any benchmark into account in the utility specification.

We consider an employee over the lifetime of the person's working life. The employee starts working at $t = 0$ and will retire at a fixed time T (e.g. $T = 40$). For ease of understanding, we assume that the employee does not die or become disabled during working life. Hence, our employee reaches time T with certainty. During working life, the employee pays at each time t an amount ϕw_t as contribution into the pension fund. The employee (or the pension fund) invests these contributions to save for retirement. At time T, the contributions plus investment returns have accumulated to a random amount X_T. At retirement, the pension capital X_T is converted into an annuity to finance consumption after retirement until death.

We assume that the employee seeks to maximize utility of consumption after retirement. This utility can be expressed as a function $U(X_T)$ of retirement capital at time T. Therefore, the employee will want to invest the contributions into the pension fund in the best possible way, such that the amount of capital at retirement gives the employee the optimal utility. We can formulate this as an optimization problem:

$$\begin{aligned} &\max_{X_T} \ \mathbb{E}\left[U(X_T)\right] \\ &\text{s.t. } \mathbb{E}^{\mathbb{Q}}[X_T] = \phi T \end{aligned} \tag{3.1}$$

The first line states that the employee seeks to maximize the expected utility of capital $U(X_T)$ at time T. The second line states the budget constraint: the present value of the capital X_T at time $t = 0$ must be equal to the present value ϕT of the pension contributions over the working career $[0, T]$. Note that in this formulation of the problem we only focus on the optimal choice of capital X_T at retirement. Once we obtain the optimal capital X_T^*, then the investment strategy which replicates this optimal payoff can be reconstructed from the terminal payoff. This approach which was introduced independently by Karatzas et al. (1986) and Cox and Huang (1989) is known as the "martingale formulation" of optimal investment problems.

The optimal terminal capital for the optimization problem (3.1) satisfies the following first-order condition:

$$\frac{\partial U(X_T^*)}{\partial X_T^*} = U'(X_T^*) = \nu Q_T \quad \Longleftrightarrow \quad X_T^* = I(\nu Q_T), \tag{3.2}$$

where $I(y)$ denotes the inverse function of $U'(x)$ and ν is a scaling constant that is chosen such that the budget constraint $\mathbb{E}^{\mathbb{Q}}\left[I(\nu Q_T)\right] = X_0$ is satisfied.

We can provide the following economic intuition for the optimality condition (3.2). For each state of the world ω that can occur at time T, the employee wishes to allocate an amount of capital $X^*_T(\omega)$. If the employee allocates €0.01 extra to the capital in this state of the world, then the utility for this state of the world increases by $U'\left(X^*_T(\omega)\right)$ 0.01. However, the present value at time $t = 0$ of this extra €0.01 is measured by the pricing kernel 0.01 $Q_T(\omega)$. Hence, the optimal allocation of capital over all states of the world is such that in each state of the world the marginal utility $U'\left(X^*_T(\omega)\right)$ is proportional to the marginal cost $Q_T(\omega)$. The constant of proportionality ν can be interpreted as the shadow-price of the budget constraint.
Note, that expression (3.2) for the optimal capital holds for *any* utility function $U(x)$ that is monotonically increasing and concave. For these utility functions, the derivative $U'(x)$ is a monotonically decreasing function; the inverse function $I(y)$ is therefore also a well-defined monotonically decreasing function.

A well-known class of utility functions are power-utility functions of the form

$$U(x) = \frac{x^{(1-\gamma)} - 1}{1-\gamma} \quad \text{with } \gamma > 0. \tag{3.3}$$

These utility functions have constant relative risk aversion (CRRA): $-U''(x)/U'(x) = \gamma/x$ for $x > 0$. Furthermore, we have $U'(x) = x^{-\gamma}$ and $I(y) = y^{-1/\gamma}$. For an employee with power-utility of terminal capital, the optimal capital can be expressed as

$$X^*_T = (\nu Q_T)^{-1/\gamma} = \bar{\nu}\, e^{\frac{\lambda}{\gamma} W_T} \tag{3.4}$$

where $\bar{\nu}$ denotes another scaling constant, which is determined from the budget equation $\mathbb{E}^{\mathbb{Q}}[X^*_T] = X_0$. The optimal capital can be given in full explicit form as

$$X^*_T = X_0 e^{\frac{2\gamma-1}{2\gamma}\frac{\lambda^2}{\gamma}T + \frac{\lambda}{\gamma}W_T} = X_0 e^{-\frac{1}{2}\left(\frac{\lambda}{\gamma}\right)^2 T + \frac{\lambda}{\gamma}W^{\mathbb{Q}}_T}. \tag{3.5}$$

The optimal capital process X^*_t is a $\mathbb{Q}$-martingale for $0 \leq t \leq T$. The employee (or the pension fund on the employee's behalf) can replicate this optimal capital process by investing in a self-financing portfolio by holding π_t stocks at each time t. The optimal investment strategy π^*_t is given by

$$\pi^*_t S_t = \frac{\lambda}{\gamma\sigma} X^*_t \tag{3.6}$$

where $\pi^*_t S_t$ denotes the amount of money invested in the stock-index at time t. This is the celebrated result introduced by Merton (1969): a power-utility investor should hold a *constant fraction* (i.e. $\lambda/(\gamma\sigma) = (\mu - r)/(\gamma\sigma^2)$) of the current capital X^*_t invested in the stock-market.

The notion of "current capital" must be carefully interpreted here. The capital-process X_t^* is based upon the ($\mathbb{Q}$-expectation of the) total stream of contributions $\int_0^T \phi w_s \, ds$ over the entire working life of the employee. At time t, we can split this integral into two parts:

- $\bar{X}_t := \int_0^t \phi w_s \, ds$, which represents the contributions paid during $[0, t]$;
- $\mathbb{E}_t^{\mathbb{Q}}[\int_t^T \phi w_s \, ds]$, which represents the value of future contributions also known as the *human capital* of the employee.

When we use the value of paid contributions $\bar{X}_t$ as a yard-stick, then the optimal investment strategy looks quite different as we obtain the well-known life-cycle investment strategy: $\pi_t^* S_t/\bar{X}_t = (\lambda/\gamma\sigma)X_t^*/\bar{X}_t$. For small values of t, the ratio $X_t^*/\bar{X}_t$ is much larger than 1, and we take a large position (even very large) in the stock-market (relative to $\bar{X}_t$). For increasing values of t, the ratio $X_t^*/\bar{X}_t$ decreases towards 1 and the position in the stock-market decreases (relative to $\bar{X}_t$). This is the life-cycle investment strategy, where we "de-risk" towards the retirement date T. Another way of looking at this result is that a young employee has paid little in contributions, but has a large human capital. By investing an amount $(\lambda/\gamma\sigma)X_t^*$, the young employee borrows against this large human capital to invest a fixed fraction of the "current capital" X_t^* in the stock-market. In this way this young employee maximizes the return on investments over his or her working life.

We want to conclude this section by discussing the impact of the risk-aversion parameter γ on the investment strategy. Since γ is in the denominator of the fraction $\lambda/(\gamma\sigma)$, we find that larger values of γ lead to lower investment in the stock-market. This makes intuitive sense: stocks are risky investments, and an employee with a higher risk-aversion will be less willing to accept risks. An extremely risk-averse employee with $\gamma \to \infty$ will not invest at all in the stock-market. In this case, the optimal capital X_T^* converges to the constant amount X_0, which is the present value of the pension contributions.[3]

[3] Please note that we have set the risk-free rate $r = 0$. By equivalence, we report all monetary quantities in discounted terms.

4 Power Utility with Benchmark

In this section we discuss the impact of specifying utility not in absolute terms, but relative to a benchmark. As discussed earlier, employees convert at the retirement date T their pension capital X_T into an annuity to finance their consumption after retirement until the time of death. We assume that employees seek to maximize their utility of consumption after retirement. However, we now make the assumption that employees relate their consumption after retirement to their "standard of living" attained at T. By relating the consumption after retirement to a (stochastic) benchmark, we obtain a very different type of utility function compared to the standard Merton model which we discussed in Section 3.

We assume that the employee's standard of living is linked to the wages w_T earned at time T. Given our assumption that wages are uncertain and linked to the stock-market, we can by equivalence assume that the standard of living is measured relative to the stock market S_T. So, employees can maintain their standard of living by buying annuities linked to S_T. As a further simplifying assumption, we assume that the value at time T of such an annuity is AS_T, where A is a constant annuity factor.[4]

On the other hand, the actual annuity that our employee can acquire at retirement date T is given by the retirement capital X_T. Hence, for our utility specification we assume that the employee compares the capital X_T to the stochastic benchmark AS_T. The utility of consumption after retirement can then be expressed by the utility function $U\big(X_T/(AS_T)\big)$. We can therefore formulate the employee's optimization problem as:

$$\begin{aligned} &\max_{X_T} \ \mathbb{E}\left[U\left(\frac{X_T}{AS_T}\right)\right] \\ &\text{s.t. } \mathbb{E}^{\mathbb{Q}}[X_T] = \phi T \end{aligned} \tag{4.1}$$

where the first line states that the employee seeks to maximize the expected utility of capital relative to the benchmark AS_T.

The optimal terminal capital for the optimization problem (4.1) is given by the following equivalent conditions:

$$\frac{\partial}{\partial X_T^*} U\left(\frac{X_T^*}{AS_T}\right) = U'\left(\frac{X_T^*}{AS_T}\right)\frac{1}{AS_T} = \nu Q_T \quad \Longleftrightarrow \quad X_T^* = AS_T \mathcal{I}\big(\nu AS_T Q_T\big), \tag{4.2}$$

where $\mathcal{I}()$ denotes the inverse function of $U'()$ and ν is a scaling constant that is chosen such that the budget constraint $\mathbb{E}^{\mathbb{Q}}\left[X_T^*\right] = \phi T$ is satisfied. We see that the impact of using a relative utility specification is twofold:

[4] In a more realistic setting, the annuity factor A should be a random variable that depends on interest rates, inflation and mortality rates. For ease of understanding, we abstract from this additional randomness.

- the optimal capital X_T^* is given by the benchmark AS_T times a (random) scaling factor $I(\nu AS_T Q_T)$;
- the scaling factor $I(\nu AS_T Q_T)$ depends on the product $AS_T Q_T$ and is therefore driven by the covariance of the benchmark AS_T with the pricing kernel Q_T.

For an employee with power utility of (relative) terminal capital, the optimal capital can be characterized as

$$X_T^* = (AS_T)^{1-\frac{1}{\gamma}}(\nu Q_T)^{-\frac{1}{\gamma}} = \bar{\nu}\, e^{(\frac{\gamma-1}{\gamma}\sigma+\frac{\lambda}{\gamma})W_T} \tag{4.3}$$

where $\bar{\nu}$ denotes another scaling constant, which is determined from the budget equation $\mathbb{E}^{\mathbb{Q}}[X_T^*] = \phi T$. The optimal capital process X_t^* is a $\mathbb{Q}$-martingale for $0 \leq t \leq T$. The employee (or the pension fund) can replicate this optimal capital process by the optimal investment strategy:

$$\pi_t^* S_t = \left(1 + \frac{\lambda - \sigma}{\gamma\sigma}\right) X_t^* \tag{4.4}$$

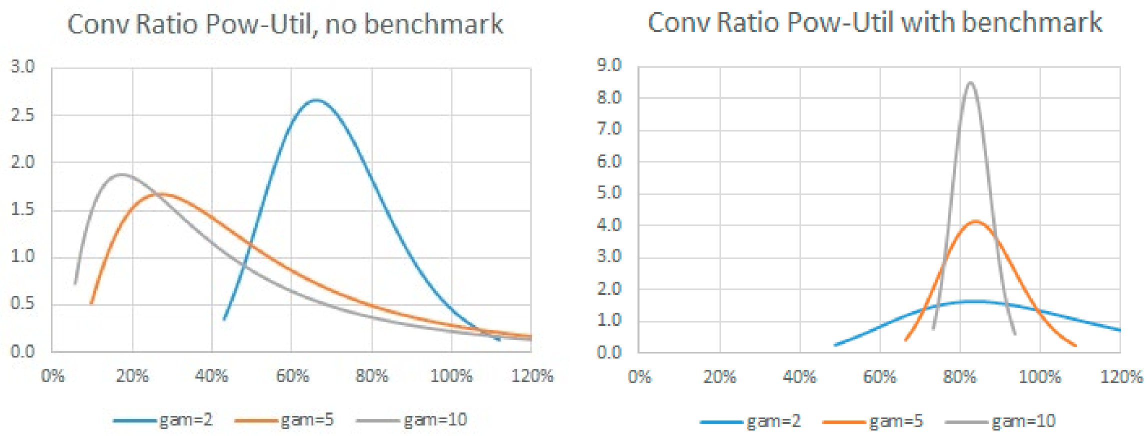
where $\pi_t^* S_t$ denotes the amount of money invested in the stock-index at time t. The optimal investment strategy consists of two parts:

- the term 1 is an investment strategy that replicates the benchmark AS_T;
- the term $(\lambda - \sigma)/(\gamma\sigma)$ is a “speculative” investment strategy that maximises the return (relative to the benchmark) for the power utility investor.

For an employee with large risk-aversion $\gamma \to \infty$, the second term disappears and we obtain a pure benchmark replicating investment strategy $\pi_t^* \to 1$. In other words, an extremely risk-averse employee will invest fully in stocks. This may seem counter-intuitive at first sight, but we must remember that employees assess the utility of their retirement capital X_T relative to the benchmark AS_T, which implies that the “risk-free” investment is obtained by replicating the benchmark.

We also need to discuss the impact of the budget constraint on the optimal investment strategy. More specifically, what happens if our employee has a benchmark AS_T that is too expensive? In other words, what happens when the value $\mathbb{E}^{\mathbb{Q}}[AS_T]$ is higher than the present value of the contributions ϕT? This discrepancy is resolved by the (random) scaling factor $I(\nu AS_T Q_T)$. In the case that $\mathbb{E}^{\mathbb{Q}}[AS_T] > \phi T$, then the scaling factor will on average be lower than 1, so that the budget constraint is satisfied.

One possible way to assess the effectiveness of the investment strategy for the employee, is to look at the replacement ratio $X_T^*/(AS_T)$. This replacement ratio measures the ratio between the capital at retirement and the benchmark. Another way of looking at this ratio is that it quantifies the relation between pre-retirement and post-retirement consumption levels.



(a) Merton investment strategy (without benchmark) *(b) Investment strategy with benchmark AS_T*

Figure 1: Distribution of Conversion Ratios for power utility

4.1 Numerical Illustration

In this sub-section, we illustrate the probability distribution of the capital X_T at retirement relative to the benchmark AS_T.

$\mu = 0.04$	$T = 40$
$\sigma = 0.16$	$\phi T = 8$
$\lambda = 0.25$	$A = 10$

Table 1: Overview of model parameters

Table 1 presents an overview of the parameters used in this example. We assume a Black-Scholes market with $\mu = 0.04$ and $\sigma = 0.16$ (and $r = 0$). For the wage development, we set the initial wage $w_0 = 1$. Over the working career, the employee pays a contribution ϕw_t with $\phi = 0.20$ into the pension fund. This leads to a present value $\phi T = 8$ for the pension contributions. For the benchmark we assume an annuity factor $A = 10$. This corresponds to present value $12.5(1 - \phi)S_T = 10S_T$ of continuing the net final wage $(1 - \phi)S_T$ for a period of 12.5 years. The present value of the benchmark at time $t = 0$ is also equal to 10. Note that this benchmark value is higher than the value of the contributions that the employee pays, leading to a "funding ratio" of the contributions equal to $8/10 = 0.80$ at $t = 0$.
In Figure 1 we show the probability distribution of the replacement ratio, i.e. the ratio $X_T^*/(AS_T)$, under the real-world probability measure $\mathbb{P}$. In the left panel, we show the results for an employee with power utility *without* benchmark, who uses the Merton-type investment strategy derived in Section 3. In the right panel, we show the results for

an employee with power utility with benchmark AS_T, who uses the investment strategy given in equation (4.4).
If we look at the probability distributions for the Merton investment strategy in the left panel, we see that this strategy leads to relatively low replacement ratios for the employee. For $\gamma = 2, 5, 10$, we get values for $\mathbb{E}[X_T^*/(AS_T)]$ of 0.71, 0.55 and 0.51, respectively. The lesson to be learned here is that a high return in euro's of the Merton strategy does not necessarily lead to a good result relative to the benchmark AS_T. It is also interesting to note that even with a high risk-aversion of $\gamma = 10$, we still have a large variance in the distribution of the replacement rates. This happens because for $\gamma \to \infty$, the Merton investment strategy shrinks into investing only in the risk-free asset. However, relative to the benchmark AS_T, this does not lead to a stable result.
In the right panel, we show the probability distributions for the replacement ratios for a power utility investment strategy that explicitly targets the benchmark AS_T. For $\gamma = 2, 5, 10$, we get average values for the replacement ratio $\mathbb{E}[X_T^*/(Aw_T)]$ of 0.94, 0.85 and 0.83, respectively. We see that explicit targeting of the investment strategy significantly improves the average replacement ratios that the employee can achieve at retirement, keeping in mind that all strategies displayed here are funded by exactly the same stream of contributions. We also see that for an employee with a high risk-aversion of $\gamma = 10$, the investment strategy converges towards replicating the budget-feasible solution $0.80AS_T = 8S_T$.

Repl-ratio	$\gamma = 2$	$\gamma = 5$	$\gamma = 10$
50%	98.5%	100.0%	100.0%
70%	82.5%	96.5%	99.9%
90%	51.5%	31.5%	7.5%
100%	37.5%	9.5%	0.0%
150%	5.5%	0.0%	0.0%

Table 2: Tail-probabilities of replacement-ratios for power utility

In Table 2, we show the tail-probabilities of the replacement ratio $\mathbb{P}[X_T^*/(AS_T) \geq c]$ for different values of c and for $\gamma = 2, 5, 10$. For a low value of the risk-aversion ($\gamma = 2$), we follow a relatively risky investment strategy in an attempt to outperform the benchmark AS_T. This leads to a replacement ratio of $c \geq 100\%$ with a probability of 37.5%. However, the investment strategy is so risky, that the probability of falling below a replacement ratio of $c = 50\%$ is also 1.5% (= 100 – 98.5%). For a moderate level of risk-aversion ($\gamma = 5$), we achieve a replacement ratio of $c \geq 100\%$ with a probability of 9.5% and a replacement ratio of $c \geq 90\%$ with a probability of 31.5%. These relatively low probabilities are due to the “underfunded” starting position of the employee. For a high level of risk aversion ($\gamma = 10$), we converge towards a fixed replacement ratio of 80%, leading to a tail probability of 99.9% of achieving a replacement ratio of at least 70% and a tail probability of 7.5% of achieving a replacement ratio of 90% or higher.

5 Double power utility with Benchmark

In this section, we look in more detail into the trade-off between:

- choosing a risky investment strategy (relative to the stochastic benchmark) with a high expected return, but a large spread in very good and very bad outcomes;
- choosing a safe investment strategy (relative to the benchmark) with a low expected return and a small spread in good and bad outcomes.

This trade-off was clearly visible in Figure 1 and Table 2, as discussed in Section 4.1.

The question we investigate in this section is the possibility of combining the best of both worlds. Is it possible to use a “gamble for resurrection” strategy in the poor states of the world with a “lock-in and replicate” strategy for the good states of the world? And if we make such a combination, does it lead to better outcomes for a pension participant?

With “better” we mean: attaining replacement ratios of 90% or higher with a high probability, without increasing the probability of bad outcomes.

One method to combine risky and safe investment strategies systematically is by changing the utility function that we work with. The defining feature of power utility is that the relative risk-aversion is constant for all levels of (relative) capital. This constant risk-aversion induces the “fix-mix” investment strategies that we saw in equation (4.4).

What happens to the probability distribution of the replacement ratio when we use a utility function that has a different risk-aversion for different levels of the replacement ratio? To examine this, we consider a utility function that is specified as follows:

- for replacement ratios $X_T/(AS_t) < 1$ we assume a *low level* of relative risk-aversion given by γ_d;
- for replacement ratios $X_T/(AS_t) > 1$ we assume a *high level* of relative risk-aversion given by γ_u.

At first sight, it may seem counter-intuitive to use a low level of risk-aversion for $X_T/(AS_t) < 1$. But we are interested in analysing the recovery potential for an “underfunded” investment problem. If we choose a high aversion whenever $X_T/(AS_t) < 1$, then we basically lock in the underfunded (but “safe”) capital at retirement. By using a “low/high” specification of the risk-aversion, we explicitly allow for a “gamble for resurrection” strategy.

The utility function that we use is obtained by “gluing” two power utility functions together where the relative risk aversion switches between two constants γ_d and γ_u. This type of *double-power* utility function is analysed in great detail in Kamma and Pelsser (2019). We refer the interested reader to this paper for further technical details.

By using two different values for γ_d and γ_u, we obtain investment strategies that dynamically move between two “fix-mix” investment strategies, depending on the (state- and time-dependent) expectation of achieving a replacement ratio above or below 1. Furthermore, by choosing a low value for γ_d and a high value for γ_u, we obtain investment

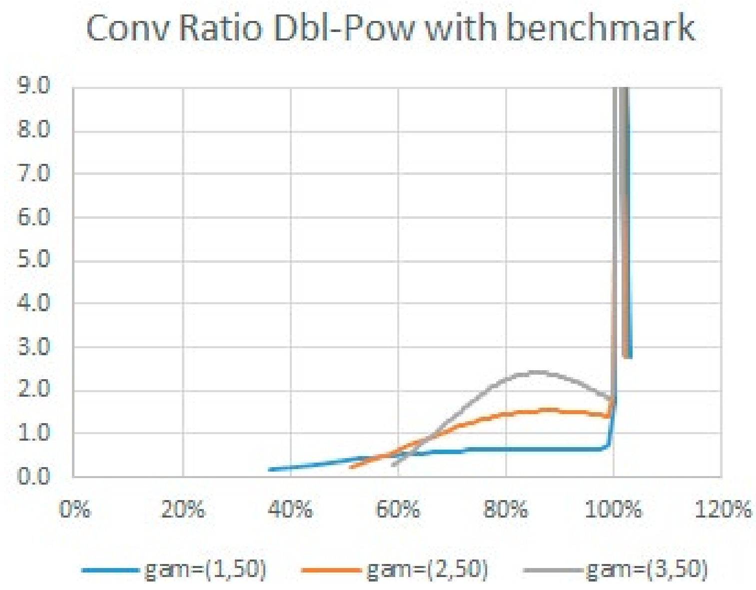


Figure 2: Distribution of Conversion Ratios for Double-power utility

strategies that are more return-seeking (and more risky) in poor states of the world and safer in good states of the world.

For our example calculations, we investigate the parameter combinations:

- γ_d = 1 and γ_u = 50;
- γ_d = 2 and γ_u = 50;
- γ_d = 3 and γ_u = 50.

For the "upper" risk-aversion, we always choose a very high value $\gamma_u = 50$. This induces a "lock-in and replicate" strategy at the first moment when sufficient investment returns have been generated by the return-seeking strategy to be able to buy the (forward) annuity for time T. By using different values of the "lower" risk-aversion, we investigate the impact of using different risk-levels for the return-seeking strategy.

The probability distributions for the replacement ratio at time T are shown in Figure 2. The effect of using a different type of utility function is once more quite profound. We now obtain probability distributions with a large concentration of probability mass at the replacement ratio of 100%. This is the effect of the very high value $\gamma_u = 50$: as soon as a sufficiently positive return has been generated by the return-seeking strategy we buy the (forward) annuity for time T and lock in the replacement ratio of 100%. However, the "gamble for resurrection" does not always work: there are also scenario paths where we never generate enough return to buy the annuity. These paths lead to replacement ratios below 100%. Different levels of γ_d generate different distributions for the below-100% replacement ratios. For example, the graph for γ_d = 1 corresponds to a quite risky investment strategy and this results in a wide range of below-100% replacement ratios. However, it also leads to a high “success rate” where we are able to lock in at 100% replacement.

Repl-ratio	γ = (1, 50)	γ = (2, 50)	γ = (3, 50)	γ = 5
50%	94.5%	99.5%	99.9%	100.0%
70%	84.5%	86.5%	90.5%	96.5%
90%	71.5%	58.5%	47.5%	31.5%
100%	65.5%	43.5%	27.5%	9.5%
105%	0.0%	0.0%	0.0%	0.0%

Table 3: Tail-probabilities of replacement-ratios for double-power utility

In Table 3, we report the tail-probabilities for the various double-power utility functions. For ease of comparison, we have repeated in the right-hand column the tail-probabilities reported in Table 2 for a “classical” power utility function with γ = 5.
If we consider the column $\gamma = (1, 50)$, which corresponds to $\gamma_d = 1$ and $\gamma_u = 50$, then we see that this leads to investment strategy that is able to achieve a “success rate” of 65.5%. This is significantly better than the 9.5% tail-probability for the $\gamma = 5$ utility function. However, this high success ratio comes at a price: the probability of ending up with a replacement ratio below 50% is now 5.5% (=100 - 94.5%).
If we consider the column $\gamma = (2, 50)$, then we use a somewhat less risky investment strategy to gamble for resurrection. In this case, we achieve a replacement ratio of $c \geq$ 100% with a probability of 43.5% and a replacement ratio of $c \geq$ 90% with a probability of 58.5%. On the other hand, the probability of ending up with a replacement ratio below 50% is now significantly reduced, namely to 0.5% (=100 - 99.5%).
This last example demonstrates that by using a different utility specification, we can significantly raise the probability of attaining high replacement ratios of 90% or 100% at the retirement date, even when we start from an initially underfunded position.

6 Conclusion

In this paper we examined the probability distribution of pension capital at retirement in a DC-type framework when using a utility function that measures the utility of capital at retirement relative to a (stochastic) benchmark with non-constant relative risk-aversion. The investment strategy thereby becomes much more geared towards attaining the benchmark capital at retirement. By using two different levels of risk-aversion above and below the replacement ratio of 100%, we obtain investment strategies that dynamically move between risky and safe investment strategies, depending on the (state- and time-dependent) expectation of achieving a replacement ratio above or below 100%. Furthermore, by choosing a low value for γ_d and a high value for γ_u we obtain investment strategies that are more return-seeking (and more risky) in poor states of the world and safer in good states of the world. Such an investment strategy ensures that retirement capital will attain the desired benchmark with a high level of probability. This demonstrates that it is possible to create DC pension schemes where the uncertainty regarding the pension capital at retirement is significantly lower compared to traditional life cycle investment strategies.

References

Bali, T. G., Demirtas, K. O., and Levy, H. (2009). Is there an intertemporal relation between downside risk and expected returns? *Journal of Financial and Quantitative Analysis*, 44(4):883–909.

Basak, S. (1995). A general equilibrium model of portfolio insurance. *The Review of Financial Studies*, 8(4):1059–1090.

Basak, S. and Chabakauri, G. (2012). Dynamic hedging in incomplete markets: a simple solution. *Review of Financial Studies*, 25(6):1845–1896.

Basak, S., Pavlova, A., and Shapiro, A. (2008). Offsetting the implicit incentives: Benefits of benchmarking in money management. *Journal of Banking & Finance*, 32(9):1883–1893.

Basak, S. and Shapiro, A. (2001). Value-at-Risk-based risk management: optimal policies and asset prices. *Review of Financial Studies*, 14(2):371–405.

Basak, S., Shapiro, A., and Tepla, L. (2006). Risk management with benchmarking. *Management Science*, 52(4):542–557.

Berkelaar, A. B., Kouwenberg, R., and Post, T. (2004). Optimal portfolio choice under loss aversion. *Review of Economics and Statistics*, 86(4):973–987.

Brennan, M. J. and Xia, Y. (2002). Dynamic asset allocation under inflation. *The Journal of Finance*, 57(3):1201–1238.

Browne, S. (2013). Beating a moving target: Optimal portfolio strategies for outperforming a stochastic benchmark. *Handbook of the fundamentals of financial decision making*, Part II:711–730.

Cox, J. C. and Huang, C.-F. (1989). Optimal consumption and portfolio policies when asset prices follow a diffusion process. *Journal of Economic Theory*, 49(1):33–83.

Kamma, T. and Pelsser, A. (2019). Near-optimal dynamic asset allocation in financial markets with trading constraints. *Available at SSRN 3403176*.

Karatzas, I., Lehoczky, J. P., Sethi, S., and Shreve, S. E. (1986). Explicit solution of a general consumption/investment problem. *Mathematics of Operations Research*, 11(2):261–294.

Merton, R. C. (1969). Lifetime portfolio selection under uncertainty: The continuous-time case. *The Review of Economics and Statistics*, 51(3):247–257.

Shen, S., Pelsser, A., and Schotman, P. (2019). Robust hedging in incomplete markets. *Journal of Pension Economics & Finance*, 18(3):473–493.

Tepla, L. (2001). Optimal investment with minimum performance constraints. *Journal of Economic Dynamics and Control*, 25(10):1629–1645.

Werker, B. (2017). The value and risk of intergenerational risk sharing. Technical Report Design Paper 84, Netspar.

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