Academic Roots
& Practitioner Reach

Climate Change & Retirement Investing Conference

JOIM & Santa Clara University – May 24, 2022

Introducing the Retirement Bond – The New Risk-Free Asset in Decumulation Investing

Lionel Martellini

Professor of Finance, EDHEC Business School

Director, EDHEC Risk Institute

Joint work with Vincent Milhau & Shahyar Safaee

Research conducted with the support of Bank of America

EDHEC-RISK Institute

Academic Roots
& Practitioner Reach

Outline

- The Decumulation Investing Problem
- Retirement Bonds in Retirement Planning
- Retirement Bonds in Retirement Investing
- Puzzles in Decumulation Investing

EDHEC-RISK Institute

- The Decumulation Investing Problem
- Retirement Bonds in Retirement Planning
- Retirement Bonds in Retirement Investing
- Puzzles in Decumulation Investing

The Decumulation Problem

- ***Accumulation problem*** – Efficiently turning *income (contribution)* into wealth:

$$\begin{cases} \max\limits_{(w_{it})_{0\le t\le T}} E_0(u(W_T)) \\ W_0; dW_t = W_t\left(\sum_{i=0}^{N} w_{it}\frac{dS_t^i}{S_t^i}\right) + c_t dt \end{cases}$$

- ***Decumulation problem*** – Efficiently turning wealth back into *income* (consumption):

$$\begin{cases} \max\limits_{(w_{it},c_t))_{0\le t\le T}} E_T\left(\int_T^{\tau} u(c_t)dt\right) \\ W_T; dW_t = W_t\left(\sum_{i=0}^{N} w_{it}\frac{dS_t^i}{S_t^i}\right) - c_t dt \end{cases}$$

An Important and Complex Problem

"The only way to avoid a catastrophe is for plan participants, professionals and regulators to shift the mindset and metrics from asset value to income."

Bob Merton (recipient of the 1997 Nobel prize in economics)

The Crisis in Retirement Planning – Harvard Business Review – July/August 2014

"Decumulation is the nastiest, hardest problem in finance."

Bill Sharpe (recipient of the 1990 Nobel prize in economics)

Tackling the 'Nastiest, Hardest Problem in Finance' – Bloomberg Opinion – June 5, 2017

A Conundrum

- **Academic insights** (starting with Merton (1969)) about **optimal** investment & income strategies $(\boldsymbol{w_t^*}, c_t^*)$ are **not actionable:**
  - c_t^* function of unobservable parameters (risk-aversion, expected returns)

- **Industry best practices** about **heuristic** investment & income strategies (w_t, c_t) are **not efficient**:
  - c_t given by ad-hoc rule (e.g., 4% rule) violating basic *efficiency* axioms

- Fixed x% spending rules inevitably lead to spending too much (**bankruptcy**) or too little (**opportunity cost**).

- Our approach: **simplify the problem** via a focus on (1) *first 20Y* versus *whole retirement* and (2) *efficiency* versus *optimality*.

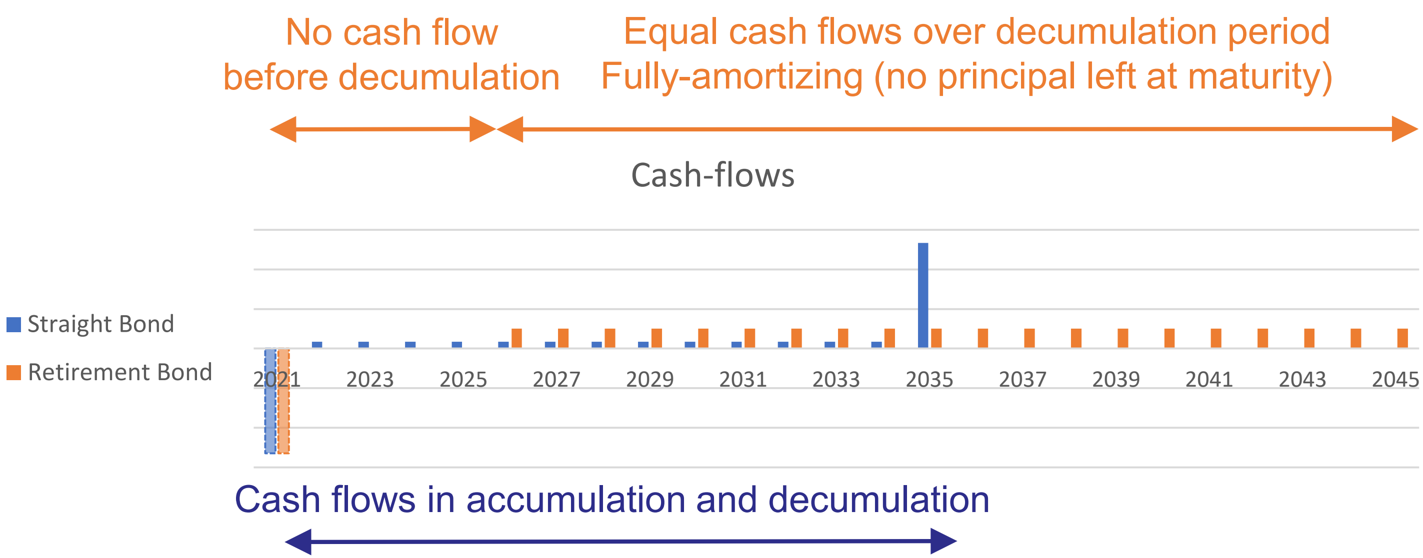
Academic Roots
& Practitioner Reach

- The Decumulation Investing Problem
- Retirement Bonds in Retirement Planning
- Retirement Bonds in Retirement Investing
- Puzzles in Decumulation Investing

EDHEC-RISK Institute

The Retirement Bond

- One key ingredient is the retirement bond, a **fully amortizing fixed-income security** paying constant (or COLA) cash-flows for first 20 years in retirement.



- Price β_t gives **purchasing power of wealth in income units**: W_t/β_t.

Issuing versus Replicating Retirement Bonds

Le Monde
SAMEDI 7 AVRIL 2018
IDÉES | 7

Pour la création « d'obligations retraite »

Trois professeurs de finance, Lionel Martellini, Robert C. Merton et Arun S. Muralidhar, suggèrent l'émission d'obligations dont l'échéance et la durée correspondraient aux âges de départ et d'espérance de vie à la retraite

Par LIONEL MARTELLINI, ROBERT C. MERTON et ARUN S. MURALIDHAR

68 Finance and economics
The Economist May 19th 2018

Pension bonds

Will Selfies stick?

An ingenious way to provide retirement income

WHEN people stop working, they need a retirement income. Some are lucky enough to have an employer-provided pension linked to their salary. Everyone else faces a difficult choice.

Some keep their pension pot in cash and watch as it is eroded by inflation. Others use savings products with high fees and risk being hurt by a stockmarket downturn. A third option is an annuity, which guarantees a lifelong income but vanishes at death, even if that is a week after retirement.

Lionel Martellini of EDHEC, a French business school, and Robert Merton of the Massachusetts Institute of Technology (a Nobel laureate in economics) have come up with an alternative. Workers would buy government-issued bonds while in employment; these would pay no interest until retirement. Over the next 20 years (the typical life expectancy on retirement) bondholders would receive payments comprising interest plus the return of the capital. These would be linked to inflation, or another measure such as average consumption. So a worker born in 1970, say, would buy a bond that made payments from 2035 until 2055. Every financial innovation needs an acronym, and these are called SELFIES (Standard of Living Indexed, Forward-starting Income-only Securities).

They would act somewhat like annuities, though without protecting against the risk of living much longer than expected. One big advantage is that if holders die before the maturity date, the capital would be passed to their heirs. They could also be attractive to corporate pension funds and institutions such as sovereign-wealth funds. But if bond yields stay as low as they are now, workers will still need a big pension pot to be able to retire comfortably. The median pension pot of an American aged 40-55 is $14,500. That will not generate much income, whatever security it buys.

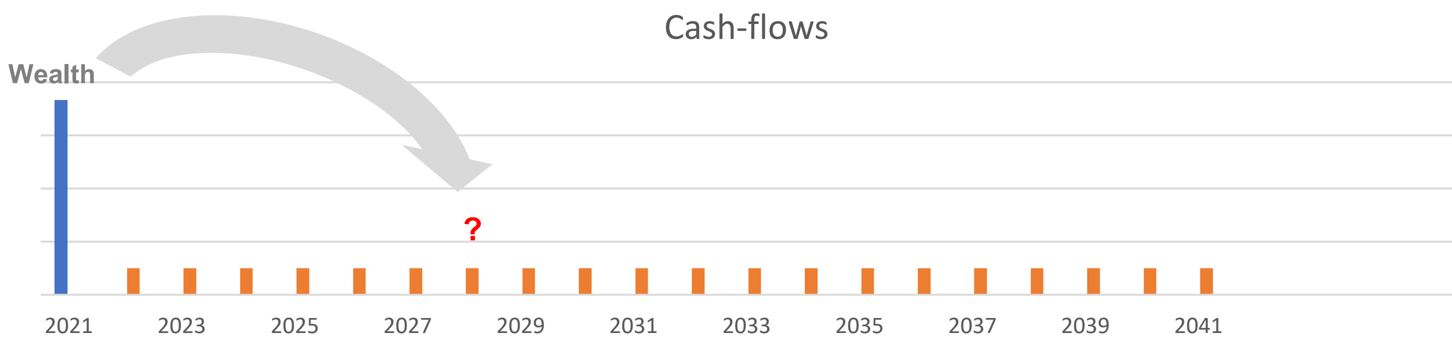
Retirement bonds (like Merton & Muralidhar's SeLFIES) do not (yet) exist but (unlike SeLFIES, which are indexed with respect to per capita consumption) **they can be replicated** (Mantilla et al. (2022)).

Academic Roots
& Practitioner Reach

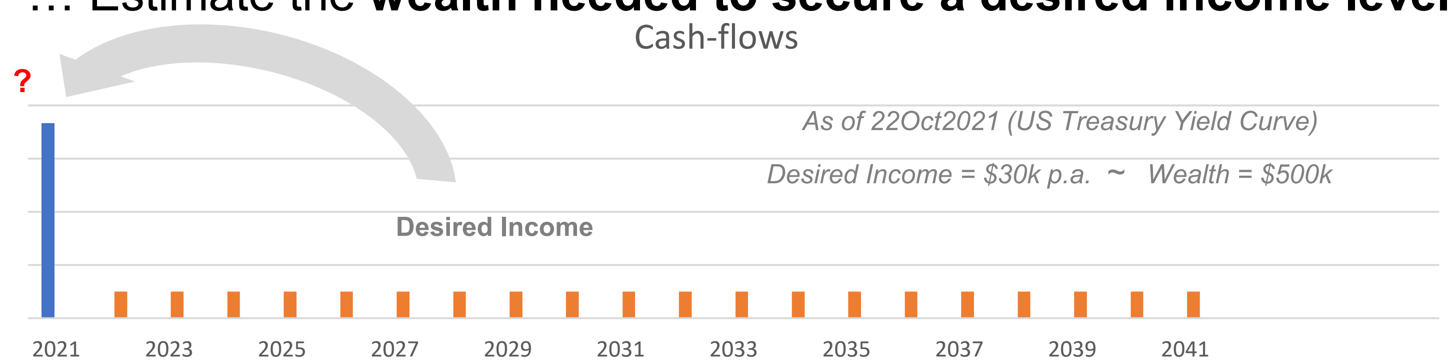
RB as a Numeraire for Turning Wealth into Income

The Retirement Bond price β_t gives **purchasing power of wealth in income units** W_t/β_t and thus allows us to...

- … Estimate the **income that a given wealth level can secure**



- … Estimate the **wealth needed to secure a desired income level**



EDHEC-RISK Institute

Benefits of Retirement Bonds for Efficient Spending

- The retirement bond price can also be used to define a new spending rule, the **maximally moderate (MM) rule:**
  - Income withdrawal defined as: $\hat{c}_t = W_{t^-}/\beta_{t^-}$ (moderation).
  - Implies **strict** maintain of purchasing power: $W_t/\beta_t = W_{t^-}/\beta_{t^-}$.
  - Final deficit/surplus is zero for all scenarios & portfolios.

- The MM rule …
  - … is purely based on observable parameters (the yield curve);
  - … generalizes the "naïve annuity" rule: $c_t = W_t/(\tau - t)$;
  - … is reminiscent of Siegel and Waring (2015) "annually recalculated virtual annuity" rule (based on an average real yield as discount rate);
  - … coincides with the solution to Merton's (1969, 1973) problem with infinite risk-aversion: $\lim_{\gamma \to \infty} c_t^* = \hat{c}_t$.

- The Decumulation Investing Problem
- Retirement Bonds in Retirement Planning
- Retirement Bonds in Retirement Investing
- Puzzles in Decumulation Investing

Optimal Decumulation Strategies with Merton Rule

- Reminder on optimal investment and consumption decisions:

$$\max_{(\boldsymbol{c_t},\boldsymbol{w_t})_{T\leq t\leq \tau}} E_T\left(\int_T^\tau u(c_t)dt\right)$$

- Optimal portfolio: Merton (1973), Munk and Sorensen (2004)

$$w_t^* = \frac{1}{\gamma}\underbrace{\Sigma_t^{-1}\mu_t}_{\substack{tangency\\ portfolio}} + \frac{1}{\gamma H}\underbrace{\Sigma_t^{-1}c_{Y,t}}_{\substack{hedging\\ portfolios}} H_Y = \frac{1}{\gamma}\underbrace{\Sigma_t^{-1}\mu_t}_{\substack{tangency\\ portfolio}} + \underbrace{\Sigma_t^{-1}c_{Q,t}}_{\substack{hedging\\ portfolios}}$$

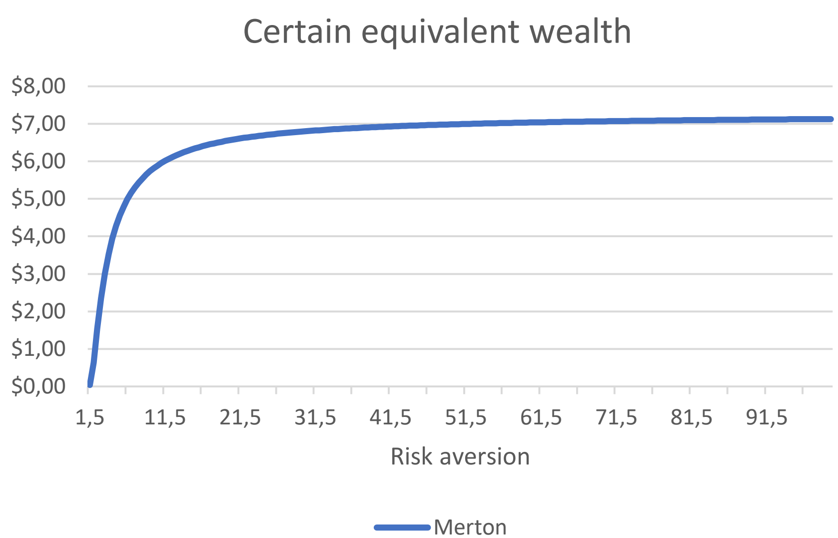
- Optimal spending (complex time- and state-dependent rule):

$$c_t^* = \frac{W_t}{Q_t}$$

with $Q_t = \int_t^\tau E_t\left[\left[\frac{M_s}{M_t}\right]^{1-\frac{1}{\gamma}}\right]ds \xrightarrow[\gamma\to\infty]{} \beta_t = \int_t^\tau b_{t,s}ds$

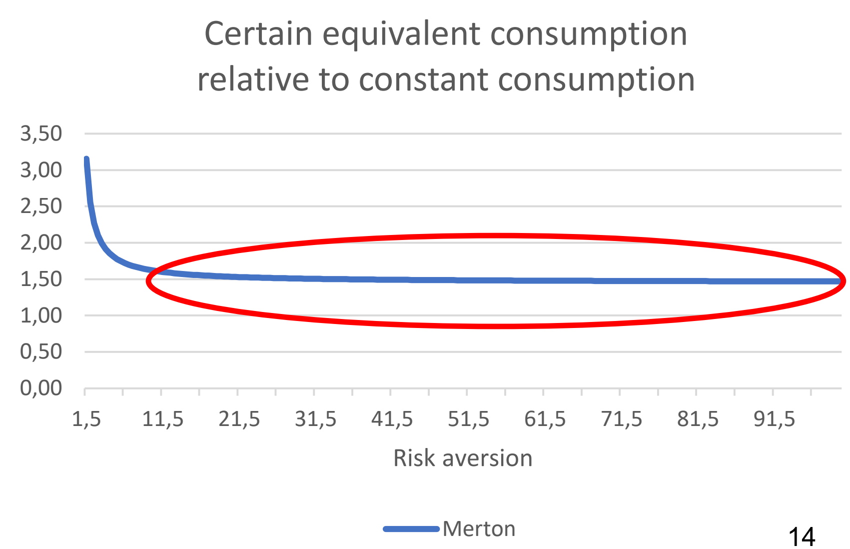
Efficiency Gains with Merton Rule (Constant Opportunity Set)

- r = 4%; λ_{MSR} = 0.5; τ-T = 20 years; W_T = $100.



Consider large gamma values (say γ>20) and give the following options to the investor:

- Option 1: Do not invest and consume $W_T/(\tau-T)$=*$5* every year for 20 years;
- Option 2: Invest and consume following Merton optimal prescriptions for 20 years.



- Option 2 generates a higher welfare compared to option 1 – actually the same welfare as consuming not $5 but 1.5x5=$7.5 every year.
- Investor could have saved $7, or 7%, to achieve the same welfare.

Optimal Decumulation Strategies with MM Rule

- Optimal investment with maximally moderate withdrawal strategy:

$$\max_{(\boldsymbol{w_t})_{T\le t\le \tau}} E_T\left(\int_T^{\tau} u(c_t)dt\right)\Bigg|_{c_t=\hat{c}_t} = \max_{(\boldsymbol{w_t})_{T\le t\le \tau}} E_T\left(\int_T^{\tau} u\left(\frac{W_t}{\beta_t}\right)dt\right)$$

- Optimal investment strategy:

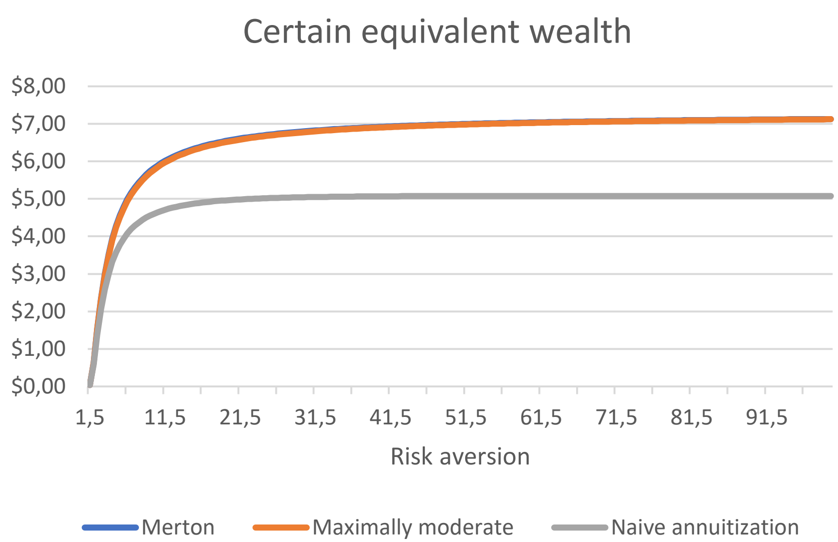
$$w_t^* = \frac{1}{\gamma}\underbrace{\Sigma_t^{-1}\mu_t}_{\substack{tangency\\portfolio}} + \left[1-\frac{1}{\gamma}\right]\underbrace{\Sigma_t^{-1}c_{\beta,t}}_{\substack{retirement\ bond\\hedging\ portfolio}} + \frac{1}{\gamma G}\underbrace{\Sigma_t^{-1}c_{Y,t}}_{\substack{hedging\\portfolios}} G_Y$$

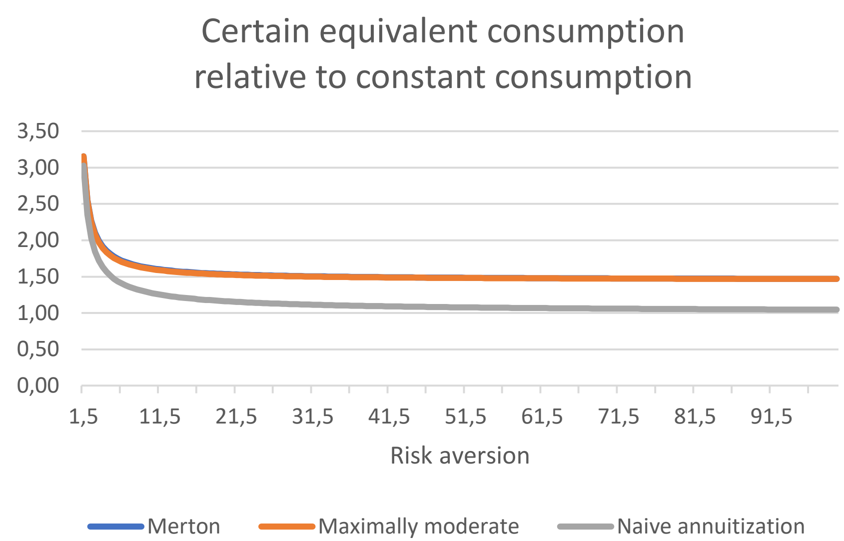
- Optimal strategy for infinite risk-aversion: 100% in retirement bond (replicating portfolio); this is the <u>only</u> (*non trivial*) decumulation strategy (i.e., joint (w_t, c_t) decision) allowing investors to enjoy constant withdrawals (obviously *not investing and spending* $\frac{W_T}{\tau - T}$ *would also work*).

Academic Roots
& Practitioner Reach

Efficiency Gains with MM and Naïve Annuitization Rules

- r = 4%; λ_{MSR} = 0.5; τ-T = 20 years; W_T = \$100.

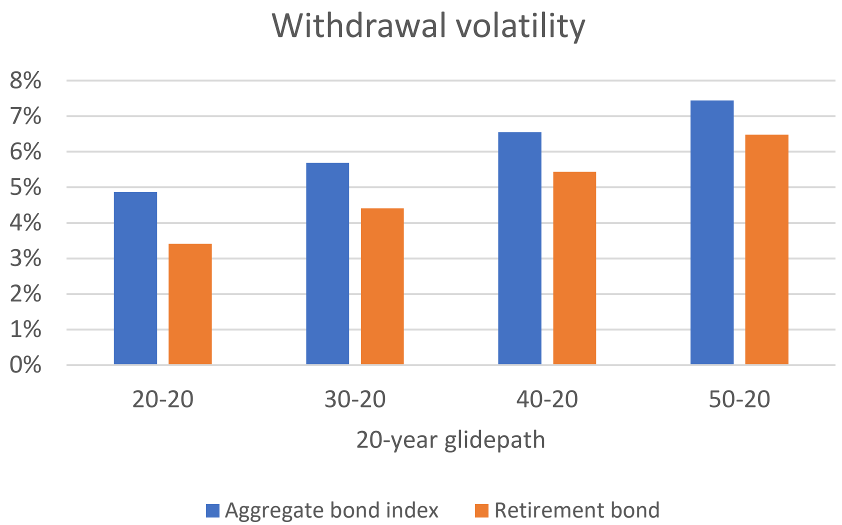


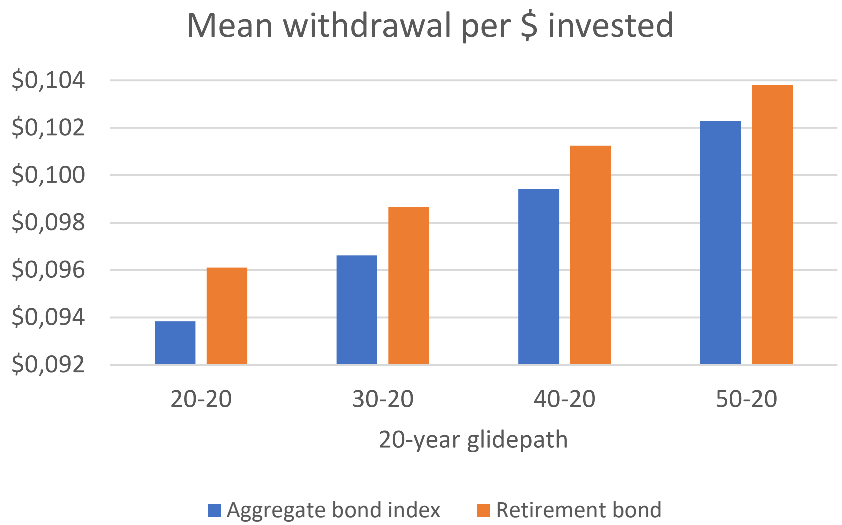


EDHEC-RISK Institute

Practical Implication – Improvement of Target Date Funds

- Using the retirement bond as the fixed-income asset allows for both higher average withdrawals and lower withdrawal uncertainty.

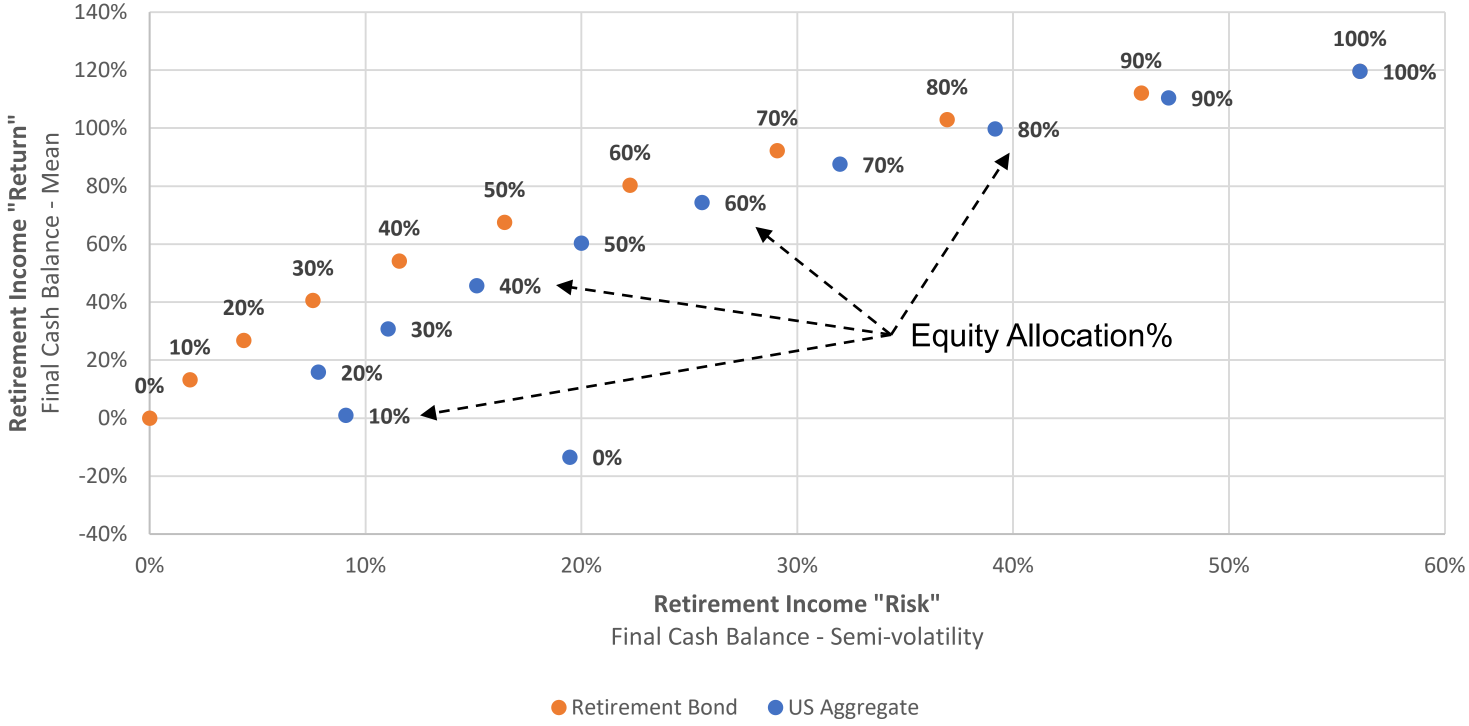




Withdrawal volatility and the mean withdrawal are calculated over each 20-year decumulation period, beginning each month end from Jul.1981 to Dec. 2020. Volatility is averaged over the 462 periods with at least two withdrawals recorded to date (periods beginning until Dec. 2019), and the mean withdrawal is averaged over the 474 periods with at least one withdrawal.

Practical Implications – Improvement of Efficient Frontiers

Using the Retirement Bond as the fixed-income building block **enhances “risk-adjusted returns”** with respect to retirement income.



The retirement bond allows for a more efficient spending of retirement income risk budget: higher equity allocation for the same risk budget.

(*) Mean and Semi-volatility of Final Cash Balance are based on historical outcomes of overlapping 20y-windows starting every month. There are 234 outcomes. The first window is July1981-July2001, the last window is Dec2000-Dec2020.

- The Decumulation Investing Problem
- Retirement Bonds in Retirement Planning
- Retirement Bonds in Retirement Investing
- Puzzles in Decumulation Investing

Puzzles in Retirement Investing

- We have identified **an efficient** (if not optimal) **decumulation strategy**.

- It relies on the retirement bond as a key ingredient:
  - Used as a **numeraire for spending decisions**;
  - Used as a building block **for investment decisions**.

- The retirement bond is a safe asset for decumulation that can serve as a useful complement or substitute for:
  - Annuities (cf. the **annuity puzzle**, Modigliani (1986));
  - Bond funds (cf. the **duration puzzle**, van Bilsten et al. (2020)).

- The retirement bond can also be used in **dynamic strategies aiming at securing minimum income levels** while allowing for upside potential.