

The logo consists of the text 'Fi360' in a white, sans-serif font, centered within a white square border. The background of the entire image is a gradient from yellow-orange at the top to red-orange at the bottom.

Fi360

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Dimensional



FI360 WEBCAST

How to Address Inflation Risk in Retirement Investing

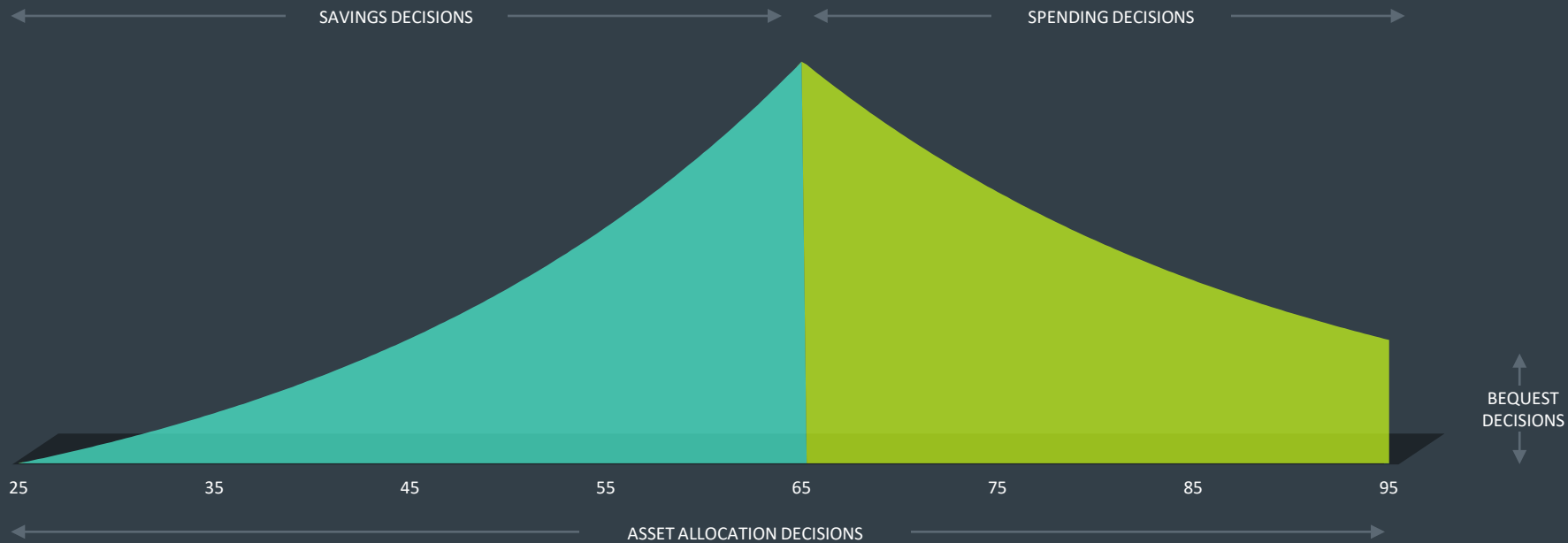
Mathieu Pellerin, PhD, Senior Researcher
John Resurreccion, Regional Director

September 9, 2021

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Motivation

Retirement planning is a lifelong journey



Hedging: eliminating exposure to a given risk

- Example #1: a farmer who sells a future contract to secure a price for his crops.
- Example #2: buying an inflation-indexed bond to hedge inflation risk.
- The gain/loss on the hedging position must move closely with the risk. Otherwise, not true hedging.
 - Counterexamples: using commodities or stocks to “hedge” inflation risk.

Market risk: the risk that the market value of an asset will fall

- Example: if interest rates go up, the value of long-term bonds will fall.

Definitions (continued)

Interest rate risk: the risk that interest rates decrease, lowering expected returns on bonds

- Example: the 10-year TIPS yield was approximately 0.1% at the beginning of 2020, compared to about -1% now.
 - One dollar invested in a 10-year TIPS held to maturity would yield \$0.90 rather than \$1.01 at maturity.
 - More savings are needed today to fund future goals.

Inflation risk: the risk that realized inflation differs from expectations

- Example: inflation is 4% when market participants expect 3%.
- Counterexample: inflation is 15% every year, with no uncertainty.

Motivation

Market risk is not the only risk for retirement income



Study Setup

\$12,500 deposits adjusted for inflation at the beginning of each year, from age 25 to 64

Asset Classes

Stocks, nominal and inflation-indexed bonds from 1 to 30 years

Asset Allocations

Two wealth-focused allocations inspired by target date funds, one income-focused allocation

Spending Rules

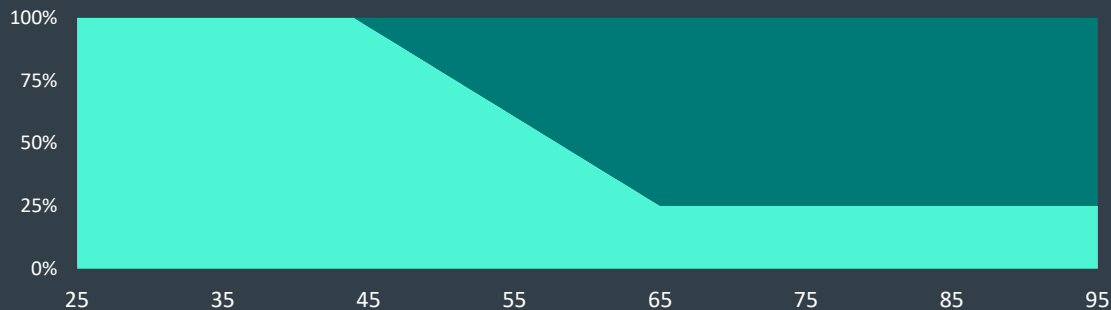
Fixed, nominal and real annuities

Strategies

Wealth-focused
high equity



Wealth-focused,
moderate equity



There is no guarantee strategies will be successful.
Hypothetical examples for illustrative purposes only.

Assets at age 65

| Percentile | Wealth-focused, high equity | Wealth-focused, moderate equity |
|---------------|-----------------------------|---------------------------------|
| 10th | \$478,436 | \$510,097 |
| 50th (median) | \$1,051,940 | \$1,021,311 |
| 90th | \$2,590,589 | \$2,314,909 |

Hypothetical performance is no guarantee of future results.

For illustrative purposes only. All simulations are based on a hypothetical probability distribution, not historical data. See Appendix for details. Hypothetical results are not representative of actual investments or actual strategies managed by Dimensional.

Initial income at age 65

| Percentile | Wealth-focused, high equity | Wealth-focused, moderate equity |
|---------------------|-----------------------------|---------------------------------|
| 10th | \$19,893 | \$21,121 |
| 50th (median) | \$44,691 | \$43,384 |
| 90th | \$111,383 | \$99,816 |
| Failure rate | 30.1% | 27.7% |

Hypothetical performance is no guarantee of future results.

For illustrative purposes only. All simulations are based on a hypothetical probability distribution, not historical data. At retirement, the investor divides her current balance by the present value of 30 inflation-indexed payments to determine her initial spending. Spending is then fixed (in real terms) throughout retirement. The present value of the 30 payments is based on a simulated real curve of real interest rates. Retirement is assumed to last 30 years. See Appendix for details.

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Interest Rate Risk

Which Investment is Riskier?

Goal: \$100 in 2 Years

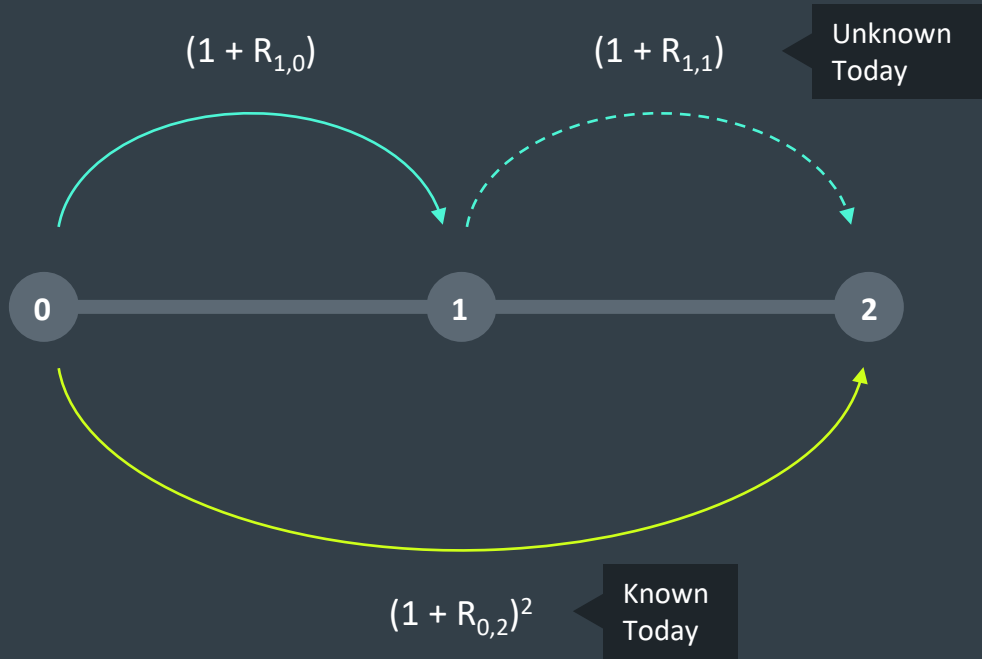
1Y

Discount Bond

or

2Y

Discount Bond



1 Year bond is risky for the goal.

Bond maturity and returns

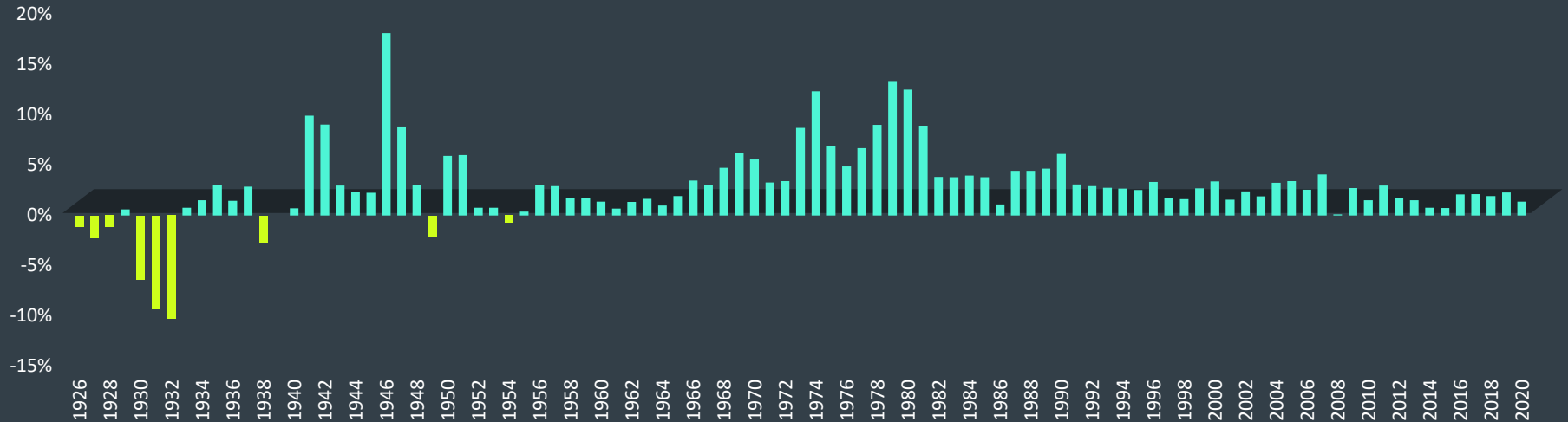
Average annual return and standard deviation, annual data, 07/1927–07/2021

| | One-Month Bills | Five-Year Treasuries |
|--------------------|-----------------|----------------------|
| Average Return | 0.40% | 2.29% |
| Standard Deviation | 3.68% | 6.33% |

Inflation Risk

Inflation History: 1926–2020

Annual changes in the US Consumer Price Index¹



1. A 25 year retirement is assumed in calculating the reduction in purchasing power.

US bills and inflation data from Stocks, Bonds, Bills, and Inflation Yearbook, Ibbotson Associates, Chicago. Roger Ibbotson is an independent director of Dimensional's US Mutual Funds, which refers to The DFA Investment Trust Company, DFA Investment Dimensions Group Inc., Dimensional Investment Group Inc. and Dimensional Emerging Markets Value Fund Inc.

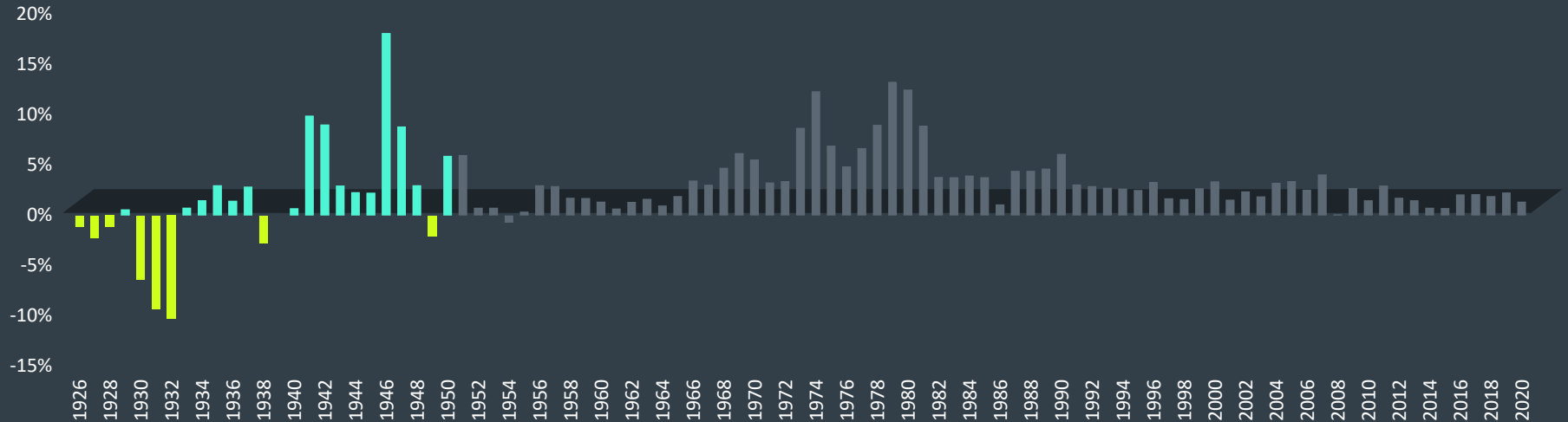
Inflation History: 1926–2020

Annual changes in the US Consumer Price Index

RETIREMENT: 1926–1950

28%

Reduction in purchasing power throughout retirement¹



1. A 25 year retirement is assumed in calculating the reduction in purchasing power.

US bills and inflation data from Stocks, Bonds, Bills, and Inflation Yearbook, Ibbotson Associates, Chicago. Roger Ibbotson is an independent director of Dimensional's US Mutual Funds, which refers to The DFA Investment Trust Company, DFA Investment Dimensions Group Inc., Dimensional Investment Group Inc. and Dimensional Emerging Markets Value Fund Inc.

Inflation History: 1926–2020

Annual changes in the US Consumer Price Index

RETIREMENT: 1926–1950

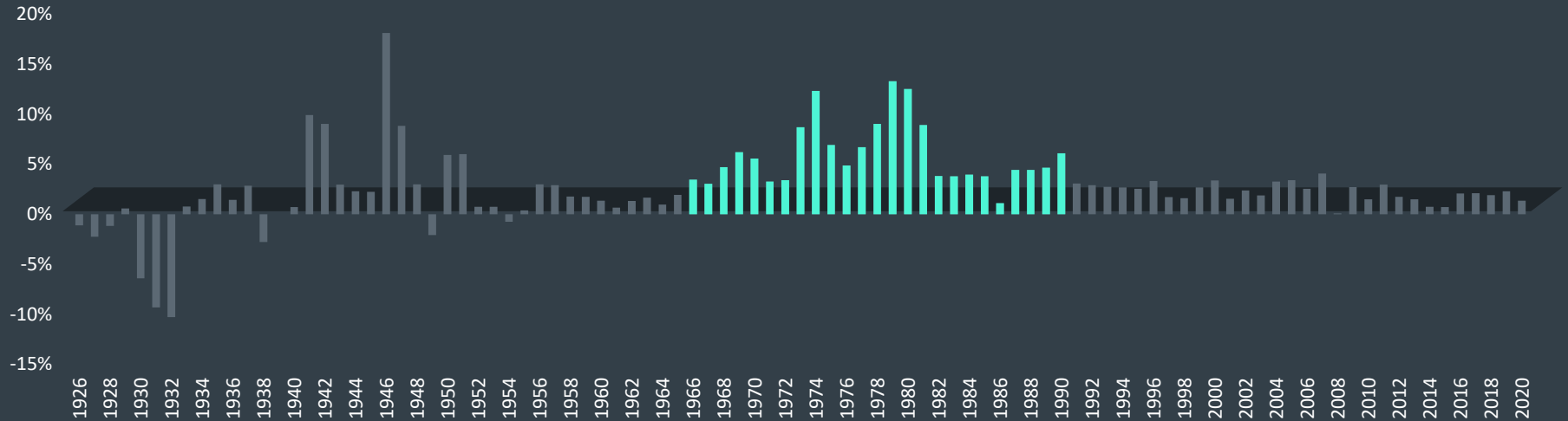
28%

Reduction in purchasing power throughout retirement¹

RETIREMENT: 1966–1990

76%

Reduction in purchasing power throughout retirement¹



1. A 25 year retirement is assumed in calculating the reduction in purchasing power.

US bills and inflation data from Stocks, Bonds, Bills, and Inflation Yearbook, Ibbotson Associates, Chicago. Roger Ibbotson is an independent director of Dimensional's US Mutual Funds, which refers to The DFA Investment Trust Company, DFA Investment Dimensions Group Inc., Dimensional Investment Group Inc. and Dimensional Emerging Markets Value Fund Inc.

Inflation History: 1926–2020

Annual changes in the US Consumer Price Index

RETIREMENT: 1926–1950

28%

Reduction in purchasing power throughout retirement¹

RETIREMENT: 1966–1990

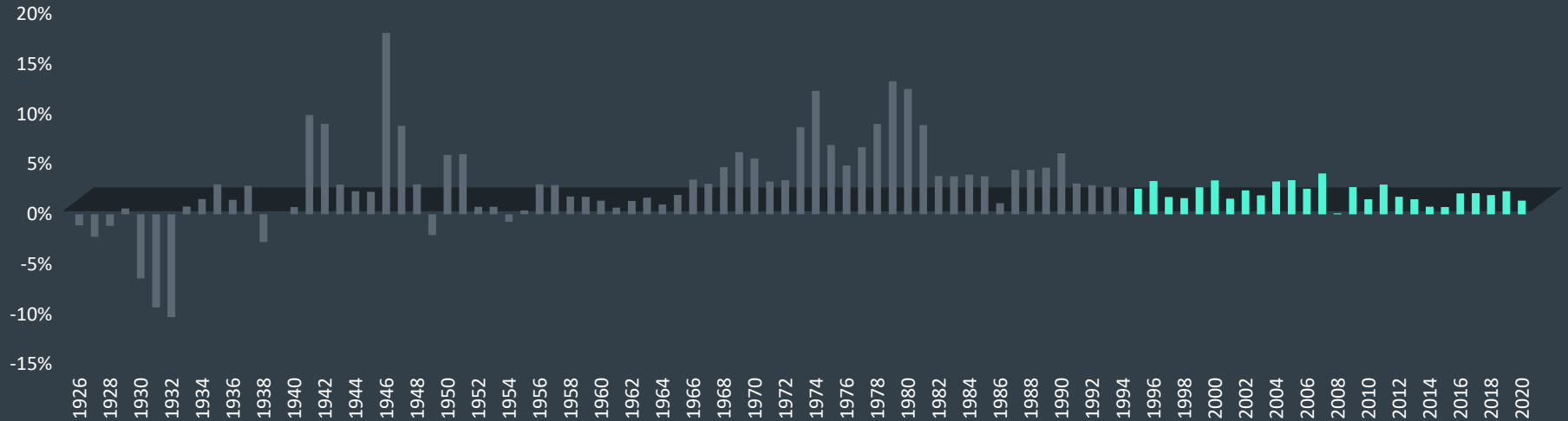
76%

Reduction in purchasing power throughout retirement¹

RETIREMENT: 1995–2020

41%

Reduction in purchasing power throughout retirement¹

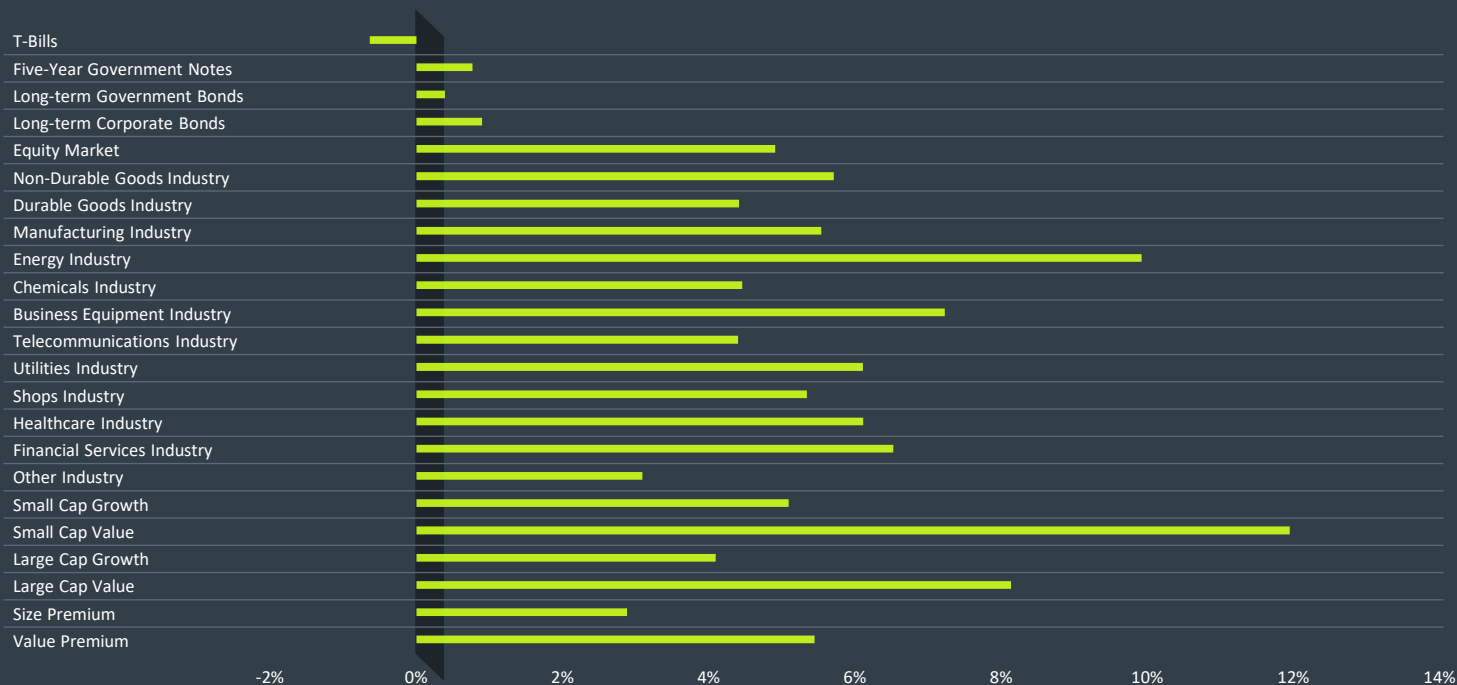


1. A 25 year retirement is assumed in calculating the reduction in purchasing power.

US bills and inflation data from Stocks, Bonds, Bills, and Inflation Yearbook, Ibbotson Associates, Chicago. Roger Ibbotson is an independent director of Dimensional's US Mutual Funds, which refers to The DFA Investment Trust Company, DFA Investment Dimensions Group Inc., Dimensional Investment Group Inc. and Dimensional Emerging Markets Value Fund Inc.

Keeping it Real

Average annual real returns in years with above-median US inflation, 1927–2020

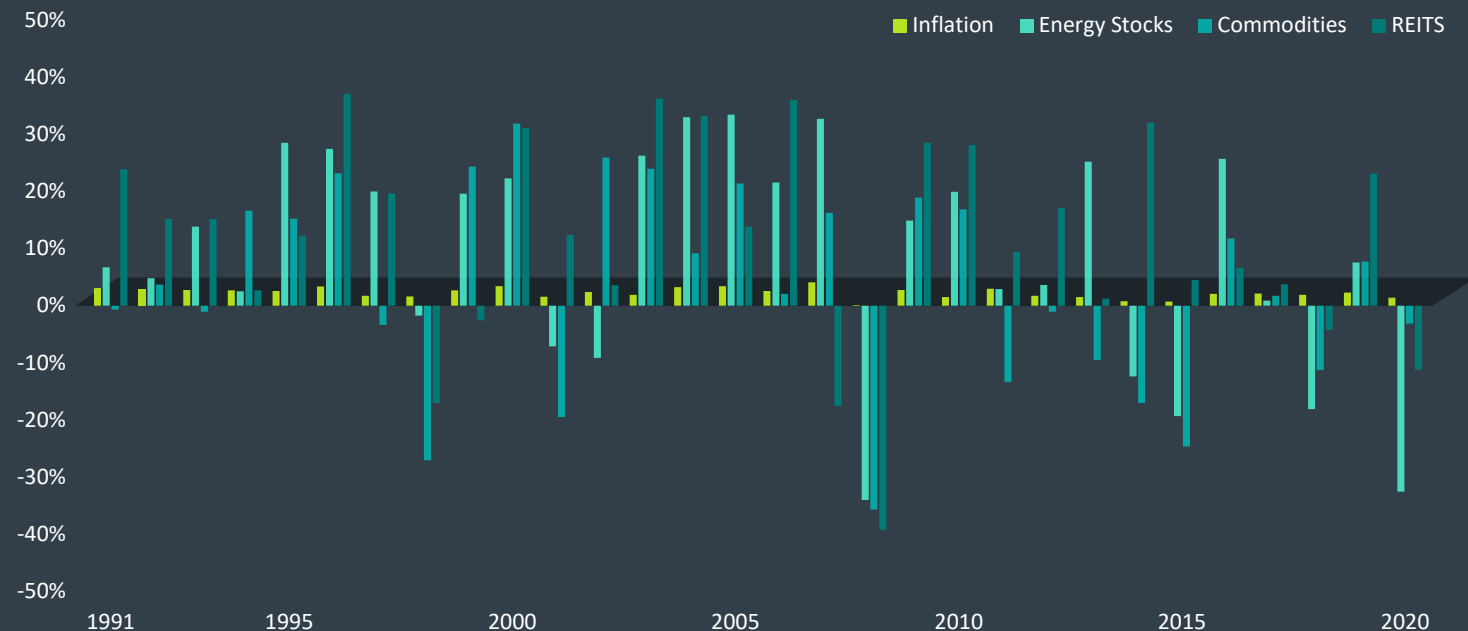


Simply staying invested helps outpace inflation over the long term for a wide range of asset classes.

Past performance is no guarantee of future results. Indices are not available for direct investment. US inflation is the annual rate of change in the Consumer Price Index for All Urban Consumers (CPI-U, not seasonally adjusted) from the Bureau of Labor Statistics. Returns are in US dollars. See Dai and Medhat (2021), available on SSRN: <https://ssrn.com/abstract=3882899>. There are 47 years with above-median inflation over the period 1927-2020. See "Data Appendix" for additional information.

One of These Things Isn't Like the Others

Annual US inflation along with nominal returns to energy stocks and commodities, 1991–2020

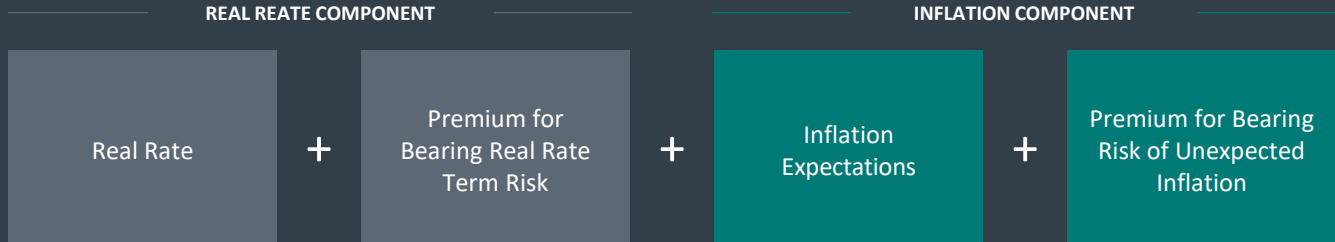


While nominal returns to energy stocks, commodities, are positively and reliably related to both expected and unexpected inflation, these assets are too volatile to be an effective inflation hedge.

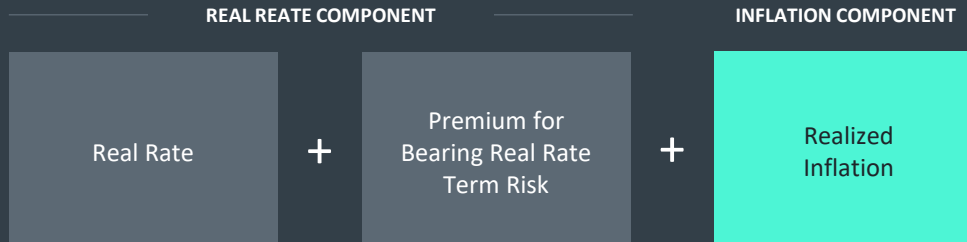
Past performance is no guarantee of future results. Indices are not available for direct investment. US inflation is the annual rate of change in the Consumer Price Index for All Urban Consumers (CPI-U, not seasonally adjusted) from the Bureau of Labor Statistics. Returns are in US dollars. See Dai and Medhat (2021), available on SSRN: <https://ssrn.com/abstract=3882899>. Energy stocks are proxied by the energy-industry portfolio from the 12 Fama/French industry portfolios. Commodities are proxied by the Bloomberg Commodity Total Return Index, which is available starting from February 1991, so its annual return for 1991 is based on the available 11 months. See "Data Appendix" for additional information.

Should you hedge inflation risk?

Nominal Bond
(Default Free)



Real Bond
(Default Free)



Inflation and interest risk

A recent example

Estimated Annual
Retirement Income

=

Account Balance

Cost of Income

| | Jan 2020 | Jan 2021 |
|--|-------------|-------------|
| Account Balance (Wealth Units) | \$1,000,000 | \$1,000,000 |
| Cost of Income | \$28.02 | \$32.71 |
| Estimated Retirement Income ¹ | \$35,689 | \$30,572 |
| 2020 | | -14% |

Hypothetical example for illustrative purposes only.

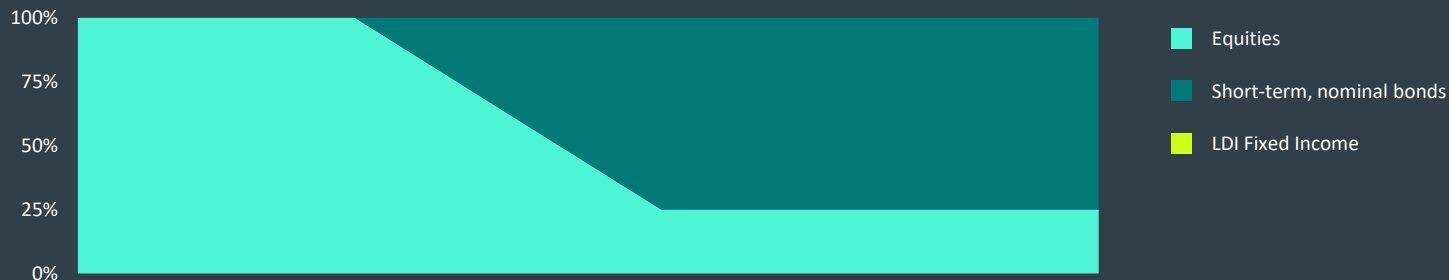
1. The Cost of Income is based on 30 years of inflation-adjusted income consumed from the accumulated balance starting at retirement. Actual income will vary.

The Cost of Income data presented in this table is rounded to two decimal places. Cost of Income is calculated using available TIPS yields and is defined as the equivalent of an inflation-adjusted stream of cash flows equal to USD \$1 per year that starts at the target retirement date and ends 30 years later. Notes and sources: TIPS yields from ICE were used. Estimated retirement income results are hypothetical, are not representative of actual investments or actual strategies managed by Dimensional.

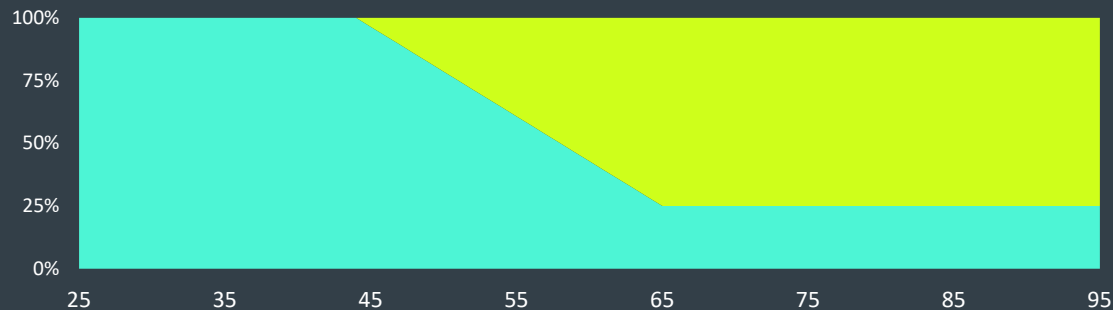
Income-Focused Investing

Strategies

Wealth-focused
moderate equity



Income-focused



There is no guarantee strategies will be successful.
Hypothetical examples for illustrative purposes only.

Initial income at age 65

| Percentile | Wealth-focused, moderate equity | Income-focused |
|---------------|---------------------------------|----------------|
| 10th | \$21,121 | \$22,118 |
| 50th (median) | \$43,384 | \$44,967 |
| 90th | \$99,816 | \$103,180 |

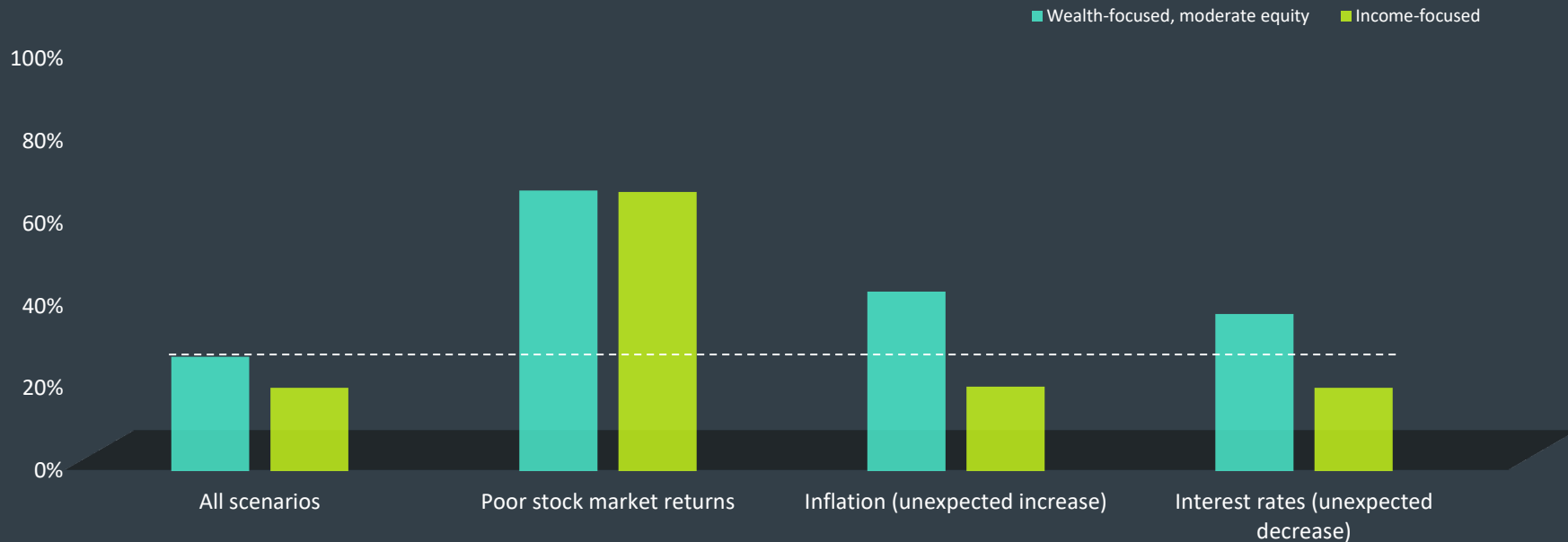
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Hypothetical results are not representative of actual investments or actual strategies managed by Dimensional.

Failure Rates

Age 95: 30 years after retirement



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The three scenarios are based on the 10% worst outcomes in the first five years of retirement. These scenarios correspond to the 10,000 simulations with the lowest average stock market return, the largest unexpected increase in inflation, and the largest unexpected decrease in interest rates, respectively, in the first five years of retirement. Failure rates are based on a 30-year retirement.

Annuitization

Longevity risk interacts with inflation risk

| | | Wealth-focused, high equity | Income-focused |
|-----------------|----------------------------------|-----------------------------|----------------|
| Nominal Annuity | Average income | \$74,808 | \$72,151 |
| | Average initial – minimum income | \$41,772 | \$40,328 |
| Real Annuity | Average income | \$80,150 | \$77,195 |

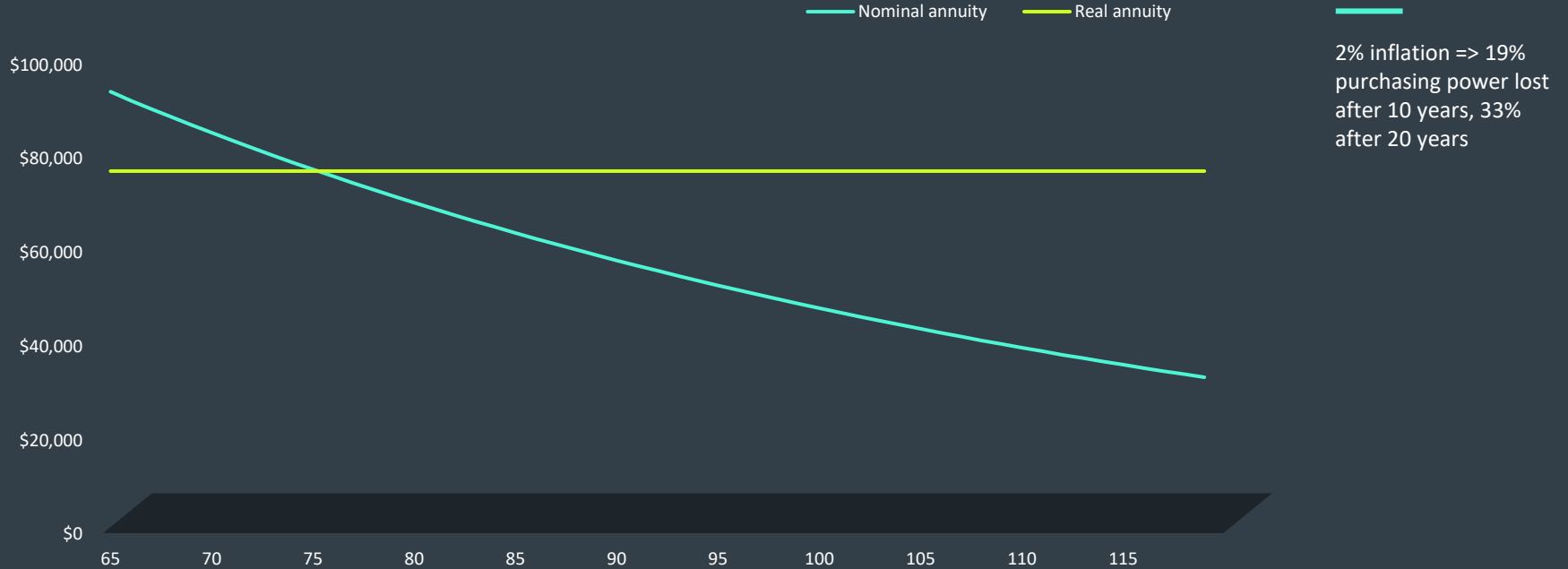
Hypothetical performance is no guarantee of future results.

For illustrative purposes only. All simulations are based on a hypothetical probability distribution, not historical data. See Appendix for details. At retirement, the investor divides her current balance by the present value of 30 inflation-indexed payments of \$1 to determine her initial spending. For fixed spending, spending is then fixed (in real terms) throughout retirement. For flexible spending, annual spending is revised each year by computing the present value of [1.5 x Conditional life expectancy of the investor] payments. Conditional life expectancy is estimated based on Social Security Administration mortality data. The present value of the payments is based on a simulated curve of real interest rates. Retirement is assumed to last 30 years. The average bequest is based on remaining assets at the end of retirement. Average income is calculated from 30 years of annuity income starting at age 65. Annuity prices are computed based on hypothetical rates at age 65.

Hypothetical results are not representative of actual investments or actual strategies managed by Dimensional.

Alternatives to fixed spending

Annuities



Annuity prices are computed based on hypothetical rates at age 65. Income numbers are expressed in real dollars based on purchasing power at age 65. Real income is fixed for real annuities, and adjusted each year based on simulated inflation rates for nominal annuities. Real income at each age is averaged over 100,000 simulations for the two types of annuities.

Key Takeaways



A more moderate allocation to equities in retirement can provide similar, but more stable income.

Historically, most assets have outpaced inflation.

During the decumulation period, inflation risk can be addressed alongside interest rate risk through an income-focused, LDI fixed income allocation.

Annuities offered even higher income in retirement, but at the expense of no bequest.

Appendix

Model (Equations + calibrated values)

$$x_t = \mu + \epsilon_t$$

$$\epsilon_t = \rho\epsilon_{t-1} + z_t$$

- The innovations z_t are independent draws from a normal distribution with mean zero. Given a calibrated value σ_y for the standard deviation of the observed variable x_t , the calibrated standard deviation of z_t equals $\sigma_z = \sigma_x (1-\rho^2)^{1/2}$.
- Three of the five variables in x_t are yield curve factors, which define the real yield curve according to

$$y_t(\tau) = (1) \cdot \beta_{1t} + \left(\frac{1-e^{-\lambda\tau}}{\lambda\tau}\right) \cdot \beta_{2t} + \left(\frac{1-e^{-\lambda\tau}}{\lambda\tau} - e^{-\lambda\tau}\right) \cdot \beta_{3t}.$$

λ is a constant equal to 0.28. τ indexes maturities while t indexes time.

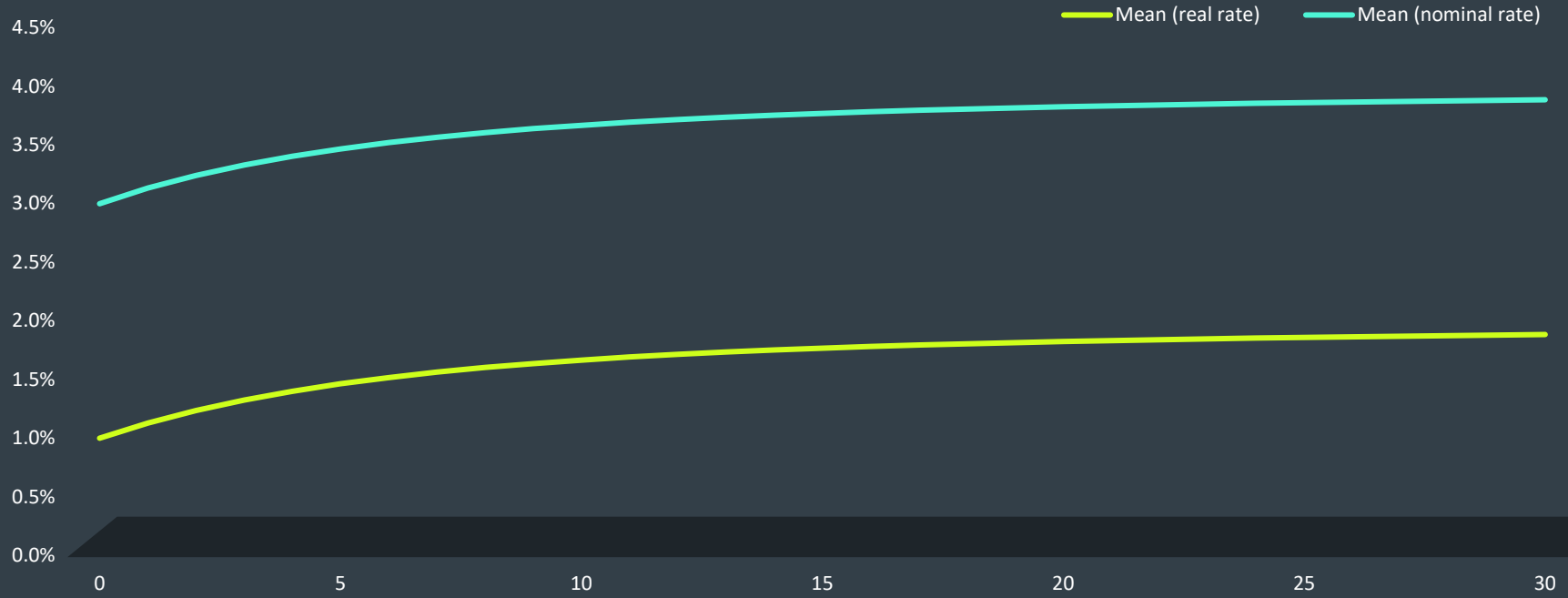
- The nominal yield curve is derived by the conditional expectation of inflation to real yields.

Model (Equations + calibrated values)

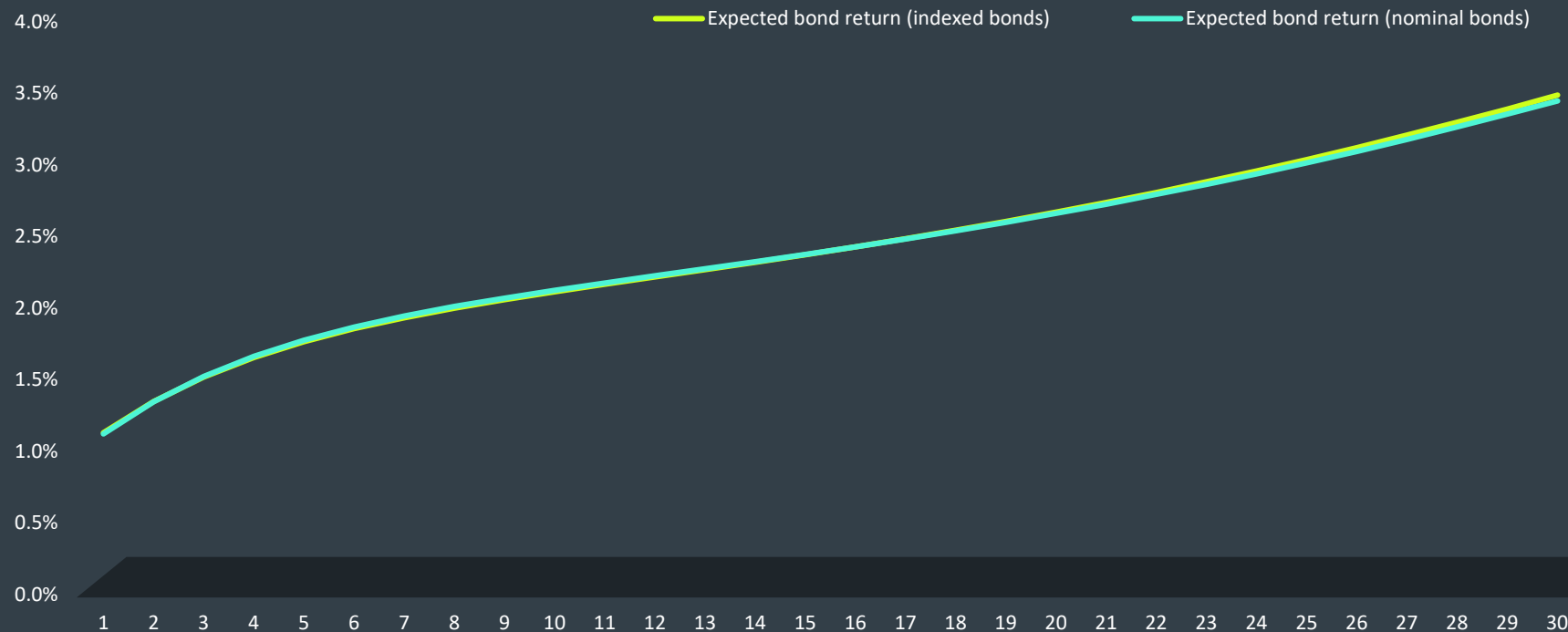
| Variable (x_t) | Average (μ) | Standard Deviation of x_t | Persistence (ρ) |
|------------------------------|-------------------|-----------------------------|------------------------|
| Stock market return (real) | 5% | 20% | 0 |
| Inflation | 2% | 1.50% | 2/3 |
| β_1 (level factor) | 2% | 1% | 5/6 |
| β_2 (slope factor) | -1% | 1.12% | 5/6 |
| β_3 (curvature factor) | 0% | 0.96% | 5/6 |

Model (Average yield curve)

Average yield by maturity



Expected returns on bonds by maturity



Selected Conditional Life Expectancies



| Age | Conditional life expectancy | Number of estimated payments |
|-----|-----------------------------|------------------------------|
| 65 | 20 | 30 |
| 75 | 12 | 18 |
| 85 | 7 | 11 |

Based on Social Security Administration mortality tables. Mortality probabilities are averaged across genders. The number of estimated payment is based on the conditional life expectancy times a 1.5 mortality buffer. Partial payments are rounded up.

Assumptions

All returns are based on computer-generated random numbers.

A hypothetical investor makes \$12,500 deposits adjusted for inflation at the beginning of each year, from age 25 to 64 inclusively. Assets are invested according to the glide paths shown in the “Strategies slide”. Allocations are rebalanced annually. The balance evolves based on returns drawn from a simulated probability distribution. At retirement, the investor divides her current balance by the present value of 30 inflation-indexed payments to determine her initial spending. The present value is based on inflation-indexed yields from a simulated yield curve. Under fixed spending, retirement is then fixed (in real terms). For flexible spending, the same calculation is carried out each year, but using an updated number of estimated payments. The number of estimated payments is obtained by multiplying an estimate of the conditional life expectancy of the investor (based on Social Security Administration mortality table) with a 1.5 mortality buffer.

Real (net of inflation) stock returns are 5% on average with a standard deviation of 20%. Inflation follows an AR(1) process with a mean of 2% and a 1.5% standard deviation. Real yields are modeled according to a three-factor dynamic Nelson-Siegel model (see Appendix A in the paper for details). Instantaneous real yields are 1% on average with a standard deviation of 1.5%, while long-term real yields have a 2% mean and 1% standard deviation. Nominal yields are derived from real yields and the expected inflation implied by the model. All bond returns are derived from the evolution of the corresponding yields.

The results presented in this blog are sensitive both to modeling assumptions and the parameter values chosen to calibrate the model. Section 2 and Appendix A in the paper provide a more complete description of the simulation methodology.

A copy of the paper is available upon request.

Disclosures



Investments involve risks. There is no guarantee strategies will be successful.

Hypothetical performance is no guarantee of future results.

Fixed income securities are subject to increased loss of principal during periods of rising interest rates and may be subject to various other risks, including changes in credit quality, liquidity, prepayments, and other factors.

A liability-driven investment (LDI) strategy is designed to focus on assets that match future liabilities. LDI strategies contain certain risks that prospective investors should evaluate and understand prior to making a decision to invest. These risks may include, but are not limited to, interest rate risk, counterparty risk, liquidity risk and leverage risk.

Data Appendix



Conventional investment methods have low odds of success

Data Sample

US-domiciled, non-Dimensional open-end mutual fund data provided by Morningstar. Dimensional fund data is provided by the fund accountant. Beginning sample includes funds as of January 1, 2000. The number of beginning funds is 4,601 for the industry and 27 for Dimensional. Dimensional subadvised funds and funds whose access is or previously was limited to certain investors are also excluded. Index funds, load-waived funds and funds of funds are excluded from the industry sample.

Methodology

Surviving funds are those with return observations for every month of the sample period. Each fund is evaluated relative to its primary prospectus benchmark. Where the full series of primary prospectus benchmark returns is unavailable, non-Dimensional funds are instead evaluated relative to their Morningstar category index. Outperformers are funds that survived the 20-year period and whose cumulative net return over the period exceeded that of their respective benchmark. We aggregate funds with multiple share classes to the strategy level.

Morningstar Categories (Equity)

Equity fund sample includes the following Morningstar historical categories: Diversified Emerging Markets, Europe Stock, Foreign Large Blend, Foreign Large Growth, Foreign Large Value, Foreign Small/ Mid Blend, Foreign Small/Mid Growth, Foreign Small/Mid Value, Global Real Estate, Japan Stock, Large Blend, Large Growth, Large Value, Mid-Cap Blend, Mid-Cap Growth, Mid-Cap Value, Miscellaneous Region, Pacific/Asia ex-Japan Stock, Real Estate, Small Blend, Small Growth, Small Value, World Large Stock, and World Small/Mid Stock.

Morningstar Categories (Fixed Income)

Fixed income fund sample includes the following Morningstar historical categories: Corporate Bond, High Yield Bond, Inflation-Protected Bond, Intermediate Core Bond, Intermediate Core-Plus Bond, Intermediate Government, Long Government, Muni California Intermediate, Muni California Long, Muni Massachusetts, Muni Minnesota, Muni National Intermediate, Muni National Long, Muni National Short, Muni New Jersey, Muni New York Intermediate, Muni New York Long, Muni Ohio, Muni Pennsylvania, Muni Single State Intermediate, Muni Single State Long, Muni Single State Short, Muni Target Maturity, Short Government, Short-Term Bond, Target Maturity, Ultrashort Bond, World Bond, and World Bond-USD Hedged.

Index Data Sources

Index data provided by Bloomberg Barclays, MSCI, Russell, FTSE Fixed Income LLC, and S&P Dow Jones Indices LLC. Bloomberg Barclays data provided by Bloomberg. MSCI data © MSCI 2021, all rights reserved. Frank Russell Company is the source and owner of the trademarks, service marks, and copyrights related to the Russell Indexes. FTSE fixed income indices © 2021 FTSE Fixed Income LLC. All rights reserved. S&P data © 2021 S&P Dow Jones Indices LLC, a division of S&P Global. All rights reserved.

Indices are not available for direct investment. Their performance does not reflect the expenses associated with management of an actual portfolio.

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Mutual fund investment values will fluctuate, and shares, when redeemed, may be worth more or less than original cost. Diversification neither assures a profit nor guarantees against a loss in a declining market. There is no guarantee investment strategies will be successful. Past performance is no guarantee of future results.

Thank You