

The Board of Trustees of the West Virginia College and Jumpstart Savings Programs

Special Meeting – Education Session

315 70th Street, SE – 2nd Floor Conference Room
Microsoft TEAMS Optional

June 7, 2023

9:00 am

After determination that a quorum of members was not present, Deputy Treasurer of Savings Programs, Amy Willard, opened the special meeting of the Board of Trustees of the College and Jumpstart Savings Programs at 9:00 AM. The following Board Members attended the meeting: Chris Heller, Marguerite Horvath, and Justin Williams.

The following consultants and guests attended the meeting: Chris Morvant, Allison Mortenson, Jim Glendon, & Justine Bartholomew representing Hartford Funds; Tim Fitzgerald representing NEPC, LLC - Program Investment Consultant; and Mathieu Pellerin & Phil Enochs, Dimensional Fund Advisors. The following WVSTO staff members attended: Amy Willard, Amy Hamilton, Andrea Herrick, Gina Joynes, Greg Curry, Karl Shanholtzer, Sarah Canterbury, Lindsay Marchio, Shana Clay, Laura Goins, Joellen Lucas, and Lisa Rutherford.

Ms. Willard began the meeting by thanking all attendees for participating in the educational session. Ms. Willard recognized Mathieu Pellerin, PhD, Senior Researcher and Vice President of Dimensional Fund Advisors, as the presenter covering the topic “Evaluating a Systemic Approach – Assessing if strategies delivered what they said they would deliver”.

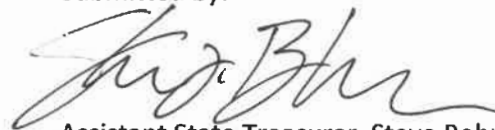
A copy of Mr. Pellerin’s PowerPoint presentation is attached hereto and made a part hereof.

After Mr. Pellerin answered questions from the attendees, the training was adjourned at 10:00 AM.

Prepared by: Elizabeth Liston

Approval Date: September 6, 2023

Submitted by:



Assistant State Treasurer, Steve Bohman

West Virginia College & Jumpstart Savings Program

Evaluating Systematic Managers

Mathieu Pellerin, PhD

Senior Researcher and Vice President

June 7, 2023

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Dimensional Fund Advisors LP is an investment advisor registered with the Securities and Exchange Commission.

Agenda

Systematic Investing

Evaluating Systematic Managers

Dimensional

- Research
- Design
- Process

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Systematic Investing

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Systematic Investing in a Nutshell

A rules-based approach to investing



RESEARCH

Identify systematic differences
in expected returns

DESIGN

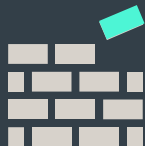
Select and weight securities
according to pre-defined criteria
to increase expected returns
within strategy constraints

EXECUTION

Maintain focus on strategy
goals while managing risks
and controlling costs

Systematic Investing in a Nutshell

If done well, systematic active can be more flexible than indexing yet more reliable and less costly than traditional active



Active *yet* Disciplined

Can pursue higher expected returns without sacrificing diversification and efficient implementation.



Additive *yet* Transparent

Can be a value-add after costs without sacrificing ease of governance and monitoring.



Repeatable *yet* Customizable

Can be tailored to goals and preferences without sacrificing a process-driven approach.

Evaluating Systematic Managers

EX-ANTE (BEFORE HIRING)

RESEARCH

- Reputation
- Framework
- Rigor

DESIGN

- Trade-offs
- Scalability
- Customization

INFRASTRUCTURE

- In-house capabilities
- Data management

PROCESS

- Portfolio management
- Trading
- Governance

CONSISTENCY

- Over time
- Across asset classes and regions

EX-POST (AFTER HIRING)

FOCUS ON PREMIUMS

- Was the strategy positioned according to its design?
- Did it capture the premiums it pursues?

RISK MANAGEMENT

- Was there clear management of concentration, style, liquidity, counterparty, and operational risks?

TRANSACTION COST ANALYSIS

- How do the prices of executed trades compare to an approach that demands liquidity?
- How do they compare to peers?

Agenda

Systematic Investing

Evaluating Systematic Managers

Dimensional

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Evaluating Research: Which Premiums?

Backed by theory?

Robust to other definitions?

Constructed according to well-established standards?

Incremental to what we already know?

Statistically reliable and economically significant?

Implementable as a value-add after costs?

Pervasive across market segments and consistent over time?

A good fit for your investment goals?

There are lots of incentives to discover premiums, but not all premiums are created equal.

A Five-Factor Asset Pricing Model

Fama and French (2015), Journal of Financial Economics

The [dividend discount] model says **the market value of a share of stock is the discounted value of expected dividends...**

With a bit of manipulation, we can extract the implications [...] for the relations between expected return and expected profitability, expected investment, and B/M... This leads us to examine a model that adds **profitability** and **investment** factors to the **market**, **size**, and **B/M** factors of the FF three-factor model.

Evaluating Research: Strategy Simulations

Purpose

Weighting scheme

Time period

Concentration controls

Investable universe

Rebalancing choices

Breakpoints

Cost assumptions

Refinements

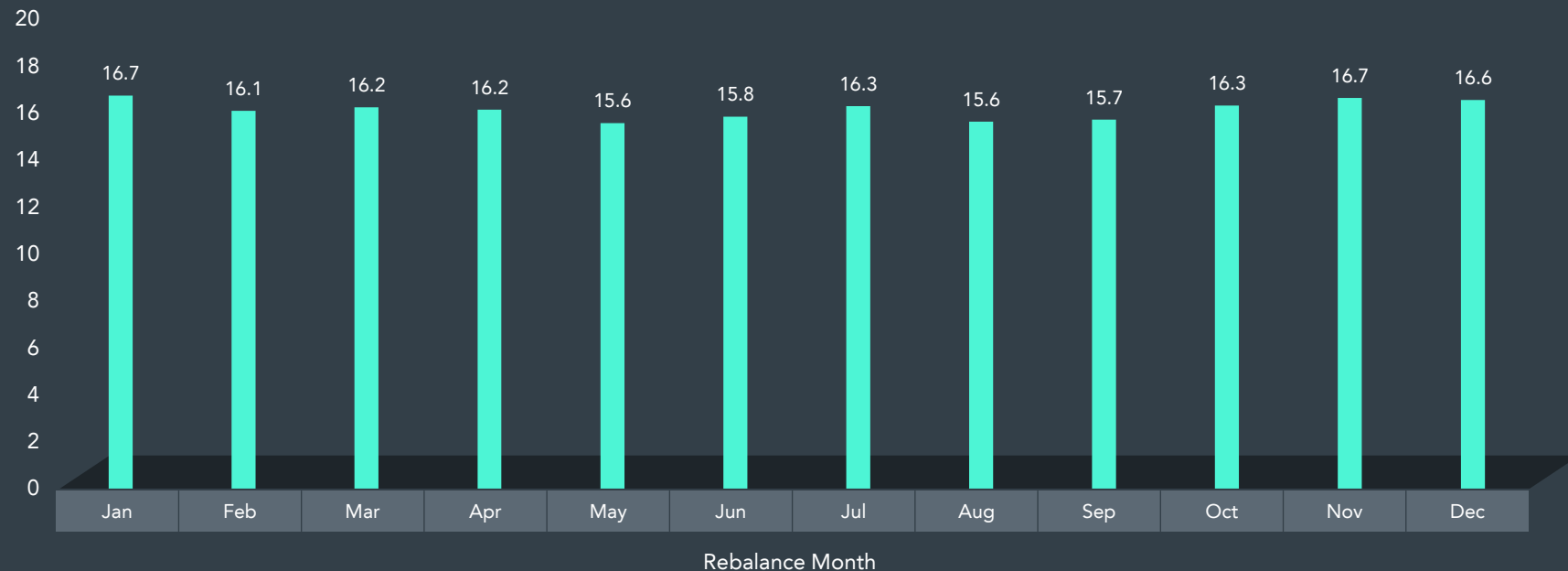
Ex-post analysis

Strategy simulations can be useful in setting reasonable expectations but are characterised by many degrees of freedom.

Noisy Data

US Small Cap Value strategy simulations. January 1973–June 2019

Annualized Compound Return (%)



Simulated data for research purposes only. This does not reflect actual performance of a live or proposed strategy. Results of an actual account may vary significantly. Simulated returns are hypothetical, are subject to numerous limitations and do not reflect costs or fees associated with an actual investment. Source: Dimensional, using CRSP and Compustat data. Simulations include small cap value firms excluding lower profitability firms. Small cap is defined as approximately the bottom 8% of the market capitalization. Value represents the bottom 35% of the market capitalization within small caps based on price-to-book ratio. In addition, the simulations exclude firms with high year-on-year asset growth, up to 5% of eligible small cap universe by market cap and consider momentum. No sector constraints are applied. Each simulation is rebalanced annually in a different month. See Appendix "Important Disclosures" for important information on simulated performance.

FOR RESEARCH AND EDUCATIONAL PURPOSES

Agenda

Systematic Investing

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Dimensional

- Research
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- Process

Adding Value in All Aspects of Implementation

Research

Understand what
drives expected returns

Portfolio Design

Increase
expected returns

Manage risks

Control costs

Portfolio Management

Use up-to-date
information to pursue
premiums every day

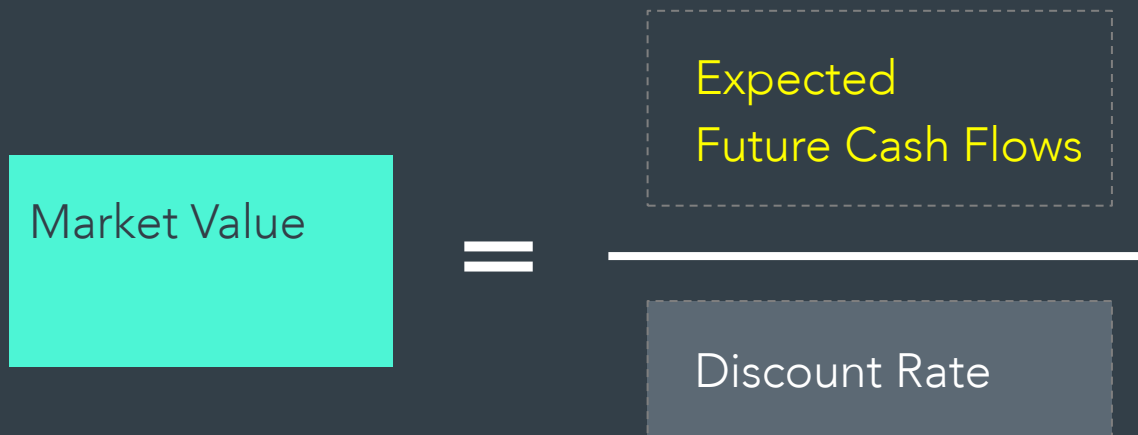
Maximize the value
of our holdings

Trading

Use flexibility to
reduce trading costs

Valuation Equation: A Framework to Understand Returns

Not all securities have the same expected return



The diagram illustrates the Valuation Equation. On the left, a solid red rectangle contains the text "Market Value". To its right is an equals sign. Further right is a horizontal line. Above this line is a dashed blue rectangle containing the text "Expected Future Cash Flows". Below the line is a dashed grey rectangle containing the text "Discount Rate".

$$\text{Market Value} = \frac{\text{Expected Future Cash Flows}}{\text{Discount Rate}}$$

Expected returns are driven by prices investors pay and cash flows they expect to receive.

Foundations of Portfolio Structure

Building blocks of asset allocation for Dimensional's equity and fixed income strategies

Equities

COMPANY SIZE

Small vs. large companies

RELATIVE PRICE¹

Value vs. growth companies

PROFITABILITY²

High vs. low profitability companies

Fixed Income

TERM

Sensitivity to interest rates

CREDIT

Credit quality of issuer

CURRENCY

Currency of issuance

1. Relative price as measured by the price-to-book ratio; value stocks are those with lower price-to-book ratios.

2. Profitability is a measure of current profitability, based on information from individual companies' income statements.

Testing the Long-Term Drivers of Expected Returns

Average monthly returns

US Large: 1963–2021

| | | PROFITABILITY | | | PROFITABILITY PREMIUM |
|---------------|--------|---------------|------|------|-----------------------|
| | | LOW | | HIGH | |
| PRICE/BOOK | GROWTH | 0.82 | 0.95 | 0.99 | 0.17 |
| | | 0.87 | 0.88 | 1.01 | 0.14 |
| | VALUE | 0.90 | 1.12 | 1.21 | 0.31 |
| VALUE PREMIUM | | 0.07 | 0.17 | 0.22 | |

US Small: 1963–2021

| | | PROFITABILITY | | | PROFITABILITY PREMIUM |
|---------------|--------|---------------|------|------|-----------------------|
| | | LOW | | HIGH | |
| PRICE/BOOK | GROWTH | 0.41 | 0.90 | 1.10 | 0.69 |
| | | 0.98 | 1.16 | 1.35 | 0.37 |
| | VALUE | 1.23 | 1.35 | 1.61 | 0.38 |
| VALUE PREMIUM | | 0.82 | 0.46 | 0.51 | |

Non-US Developed: 1975–2021

| | | PROFITABILITY | | | PROFITABILITY PREMIUM |
|---------------|--------|---------------|------|------|-----------------------|
| | | LOW | | HIGH | |
| PRICE/BOOK | GROWTH | 0.49 | 0.85 | 0.86 | 0.37 |
| | | 0.83 | 0.92 | 1.00 | 0.17 |
| | VALUE | 1.01 | 1.12 | 1.16 | 0.15 |
| VALUE PREMIUM | | 0.52 | 0.27 | 0.30 | |

Emerging Markets: 1989–2021

| | | PROFITABILITY | | | PROFITABILITY PREMIUM |
|---------------|--------|---------------|------|------|-----------------------|
| | | LOW | | HIGH | |
| PRICE/BOOK | GROWTH | 0.54 | 0.67 | 1.20 | 0.66 |
| | | 0.56 | 0.91 | 0.87 | 0.31 |
| | VALUE | 1.04 | 1.07 | 1.40 | 0.36 |
| VALUE PREMIUM | | 0.50 | 0.41 | 0.21 | |

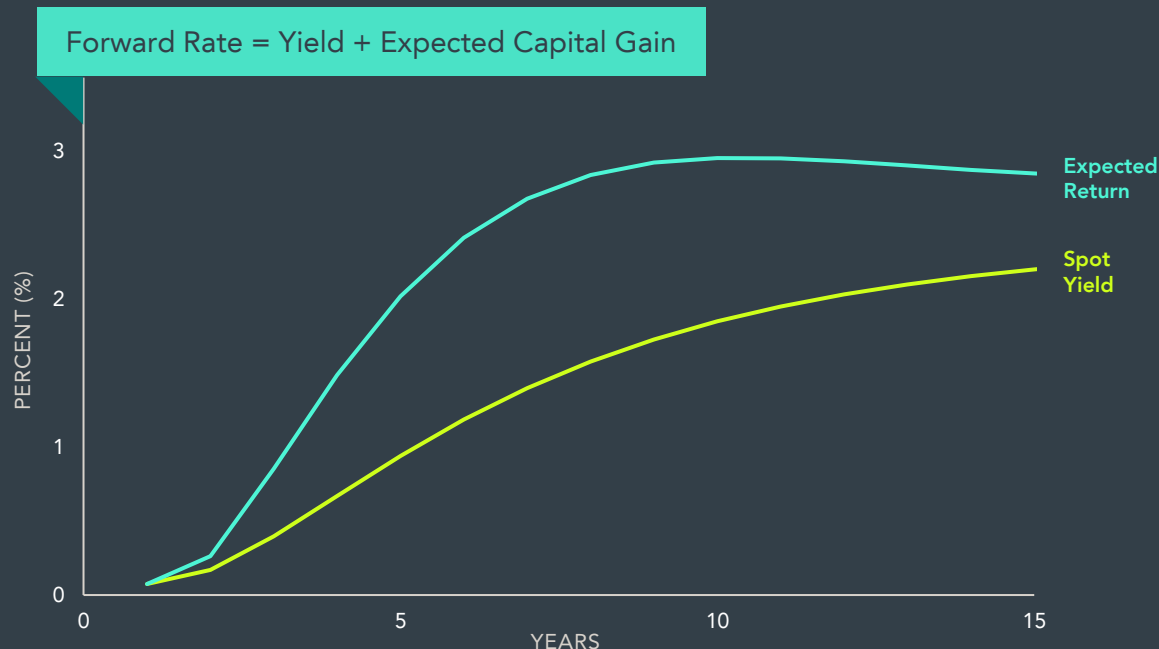
Past performance, including hypothetical performance, is no guarantee of future results. Actual investment returns may be lower.

In USD. US Large and US Small computed from Fama/French US Total Market Research Index published security weights. Non-US Developed computed from Fama/French International Market Index prior to 1990 and the Fama/French Developed ex US Market Index thereafter. Emerging Markets computed from Fama/French Emerging Markets Index. Dimensional computed security returns and Dimensional classification of securities based on size, value, and profitability parameters. The Fama/French Indices represent academic concepts that may be used in portfolio construction and are not available for direct investment or for use as a benchmark. Index returns are not representative of actual portfolios and do not reflect costs and fees associated with an actual investment. See Appendix "Testing the Valuation Equation: Descriptions and Important Information."

Estimating Expected Returns from Forward Rates

Example: government spot curve, 1-year holding period

| Years | Spot Yield (%) | Expected Return (%) |
|-------|----------------|---------------------|
| 1 | 0.07 | 0.07 |
| 2 | 0.17 | 0.26 |
| 3 | 0.40 | 0.85 |
| 4 | 0.67 | 1.49 |
| 5 | 0.94 | 2.02 |
| 6 | 1.19 | 2.41 |
| 7 | 1.40 | 2.68 |
| 8 | 1.58 | 2.84 |
| 9 | 1.73 | 2.92 |
| 10 | 1.85 | 2.95 |
| 11 | 1.95 | 2.95 |
| 12 | 2.03 | 2.93 |
| 13 | 2.10 | 2.91 |
| 14 | 2.16 | 2.87 |
| 15 | 2.20 | 2.85 |



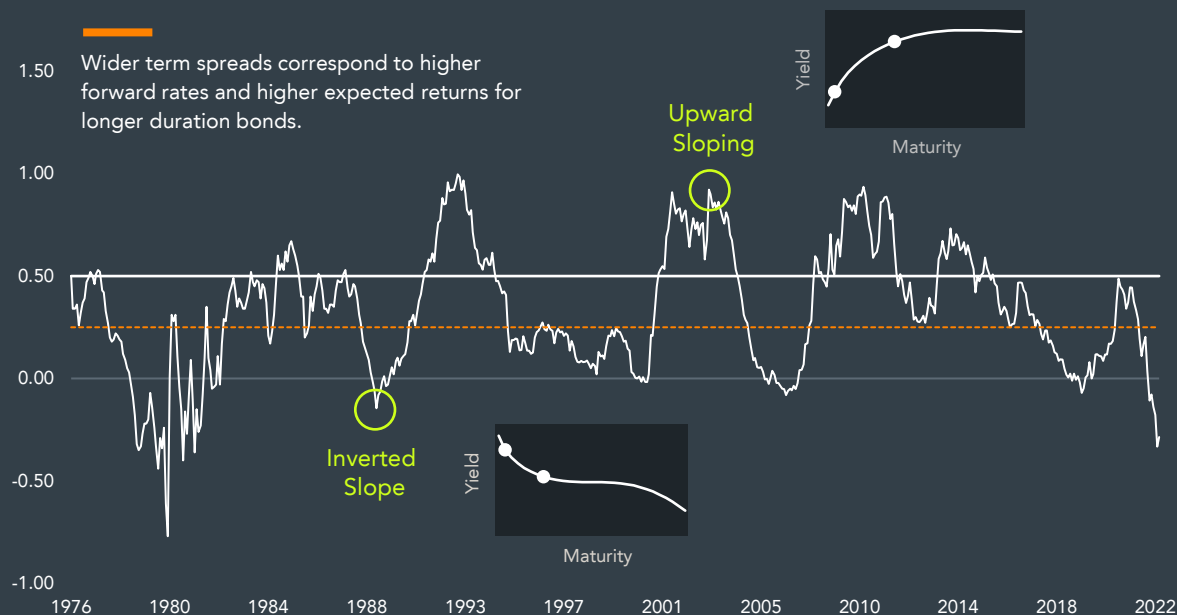
Hypothetical example for illustrative purposes only.

These expected returns are calculated by Dimensional Fund Advisors LP using yield curve data (USD) and assuming various holding periods. There is no guarantee that any product or strategy offered by Dimensional will achieve the returns shown. Any forward-looking statements speak only as of the date they are made, and Dimensional assumes no duty and does not undertake to update forward-looking statements. Forward-looking statements are subject to numerous assumptions, risks, and uncertainties, which change over time. Actual results could differ materially from those anticipated in forward-looking statements.

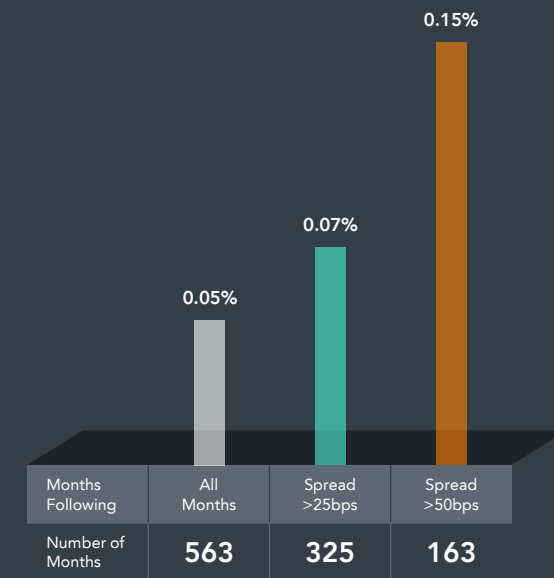
Term Spreads and Expected Returns

US Government Intermediate minus 1-3 years, 1976–2022

US Government Spread (%): Intermediate minus 1–3 years



Average Monthly Return Difference



Past performance is no guarantee of future results.

Monthly data in US dollars. Bloomberg Government 1-3 Year and Intermediate Indices.

Yield to worst: Intermediate and 1-3 Years.

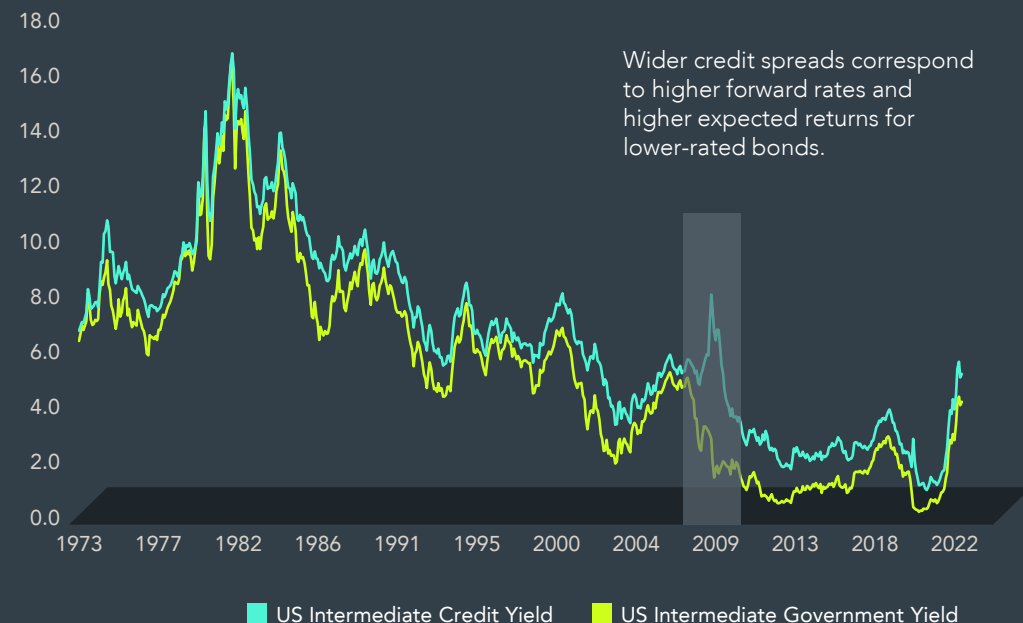
Bloomberg data provided by Bloomberg. Indices are not available for direct investment.

Credit Spreads and Expected Returns

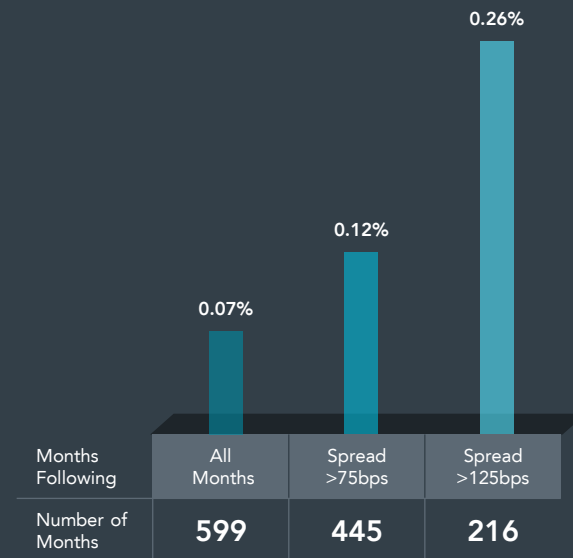
US market, January 1973–December 2022



Yield %



Average Monthly Return Difference



Past performance is no guarantee of future results.

Monthly data in US dollars. Bloomberg Intermediate Indices. Government: Bloomberg US Government Intermediate Index. Credit: Bloomberg US Intermediate Credit Index. Bloomberg data provided by Bloomberg. Indices are not available for direct investment.

Varying Credit Exposure to Increase Expected Returns

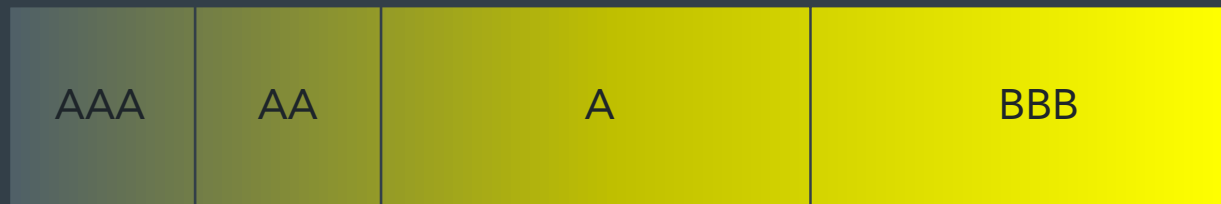
Credit spreads inform portfolio positioning



Wide Spreads

Wide credit spreads generally lead to higher credit premiums.

Emphasize lower credit quality



Narrow Spreads

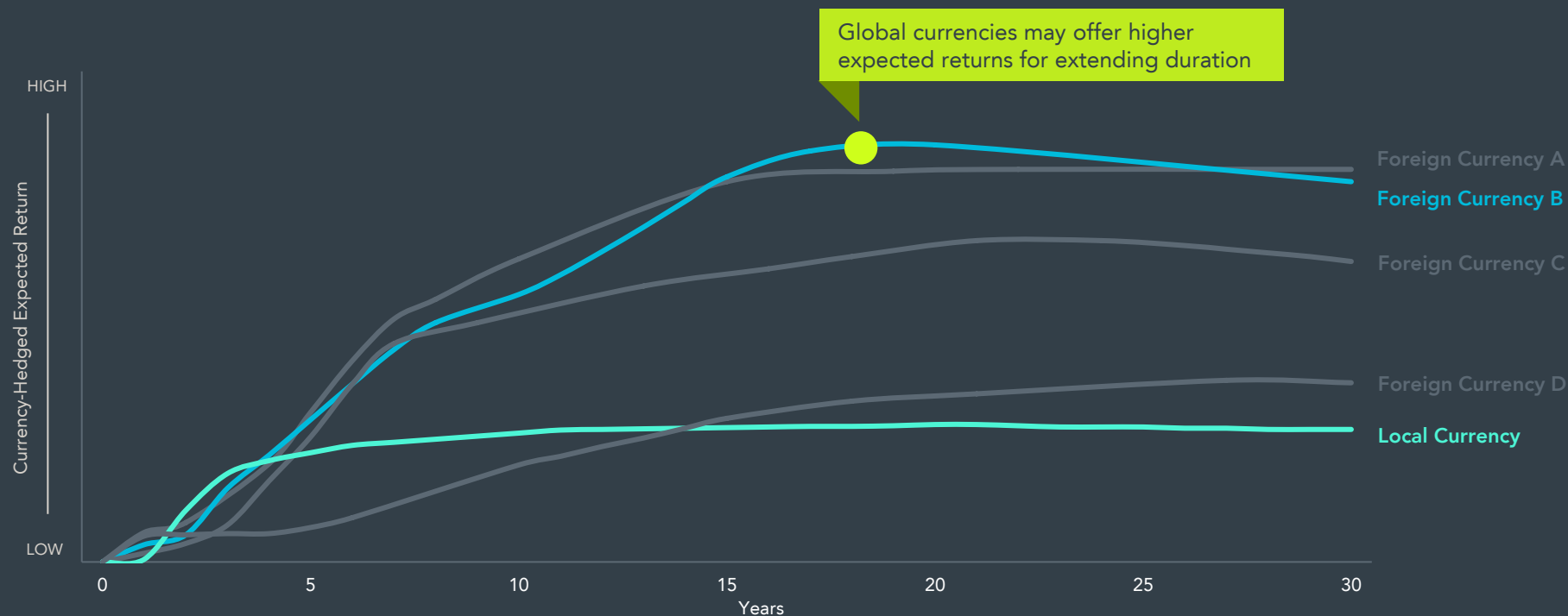
Narrow credit spreads generally lead to lower credit premiums.

Emphasize higher credit quality



A Global Opportunity for Higher Expected Returns

Investing across 12 currencies to increase expected returns and reduce volatility



Hypothetical example for illustrative purposes only.

Evaluating Design

Correspondence
with research

Scalability

Premium
interactions

Customization

Concentration
controls

Practical choices

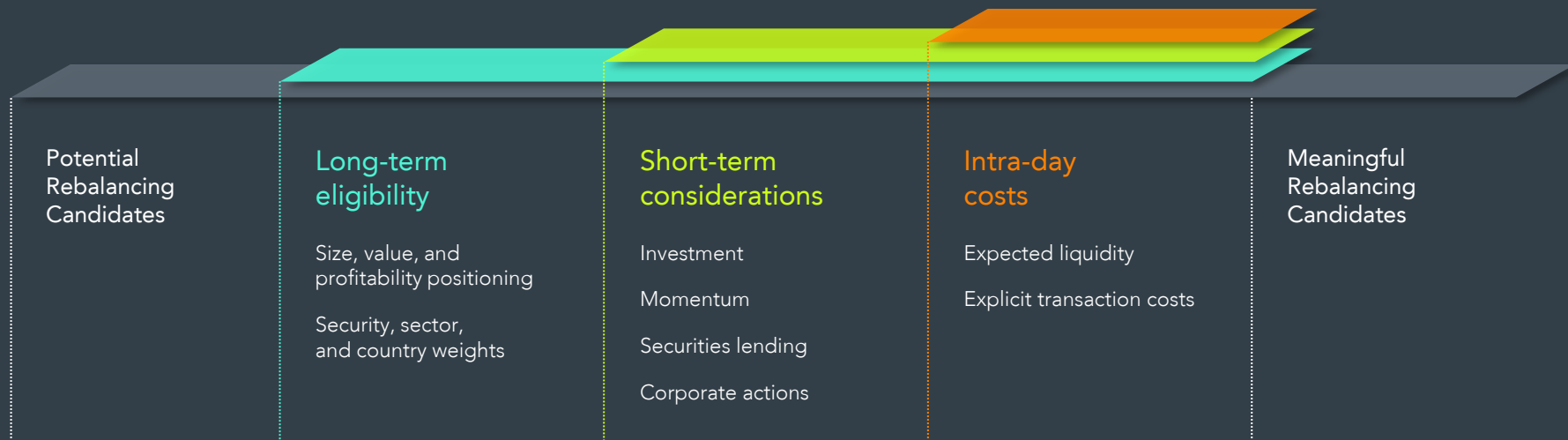
Turnover
controls

- Sorting variables
- Breakpoints
- Refinements
- Weighting scheme

For a systematic manager, portfolio design should aim to increase expected returns while managing risks and controlling costs.

Improving Expected Returns through Daily Rebalancing

Many inputs inform which stocks we want to hold each day



Evaluating Process: Portfolio Management

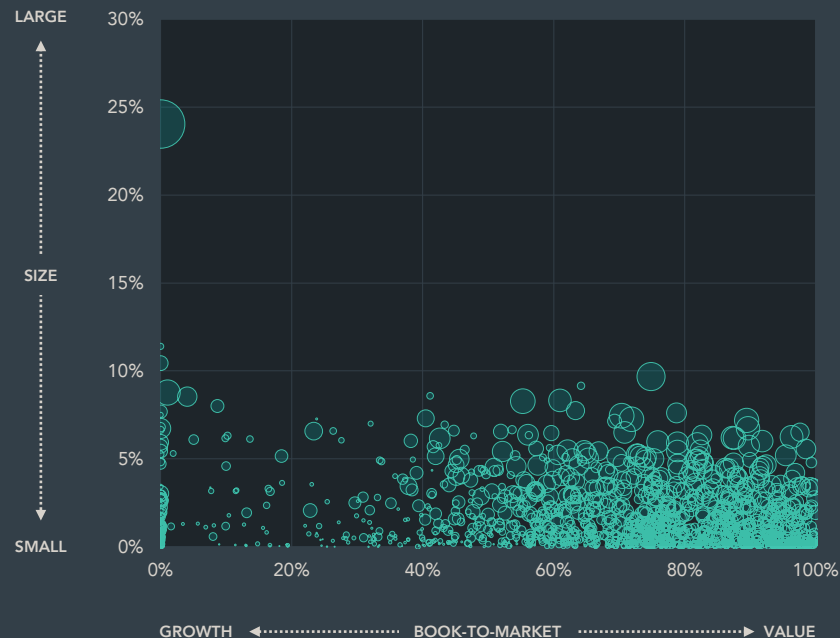
| Order Generation | Current Holdings | Risk Management |
|--|---|--|
| Frequency Rebalancing criteria Cashflow management | Securities lending Corporate actions Investment stewardship | Style drift Concentration risk Liquidity risk Counterparty risk Operational risk |

For a systematic manager, portfolio management should aim to keep the strategy positioned according to its design while maximising the value of holdings.

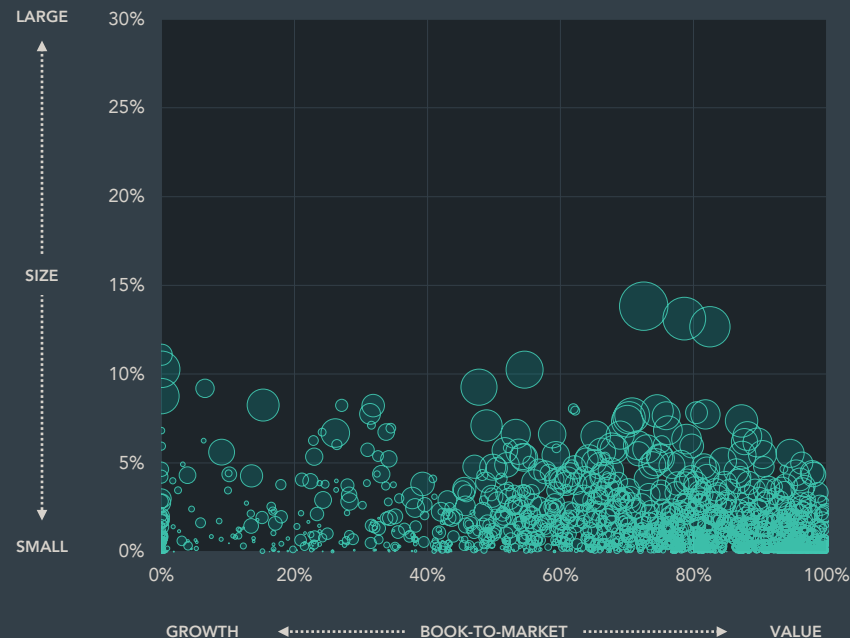
Out of Bounds

Russell 2000 Value Index holdings

As of June 30, 2021



As of May 31, 2022



Evaluating Process: Trading

| Controlling Explicit Costs | Controlling Implicit Costs | Scale and Infrastructure |
|--|--------------------------------------|---------------------------------------|
| Commissions Custody fees Exchange fees | Sizing Timing Pricing Venue | Internal order crossing FX netting |

For a systematic manager, trading should aim to execute meaningful transactions while minimising explicit and implicit costs

Trading Costs Can Be Greater Than Daily Premiums

All Country daily premiums vs. trading costs in All Country market segments

Historical Daily Premiums



Median Peer Trading Costs Per Transaction



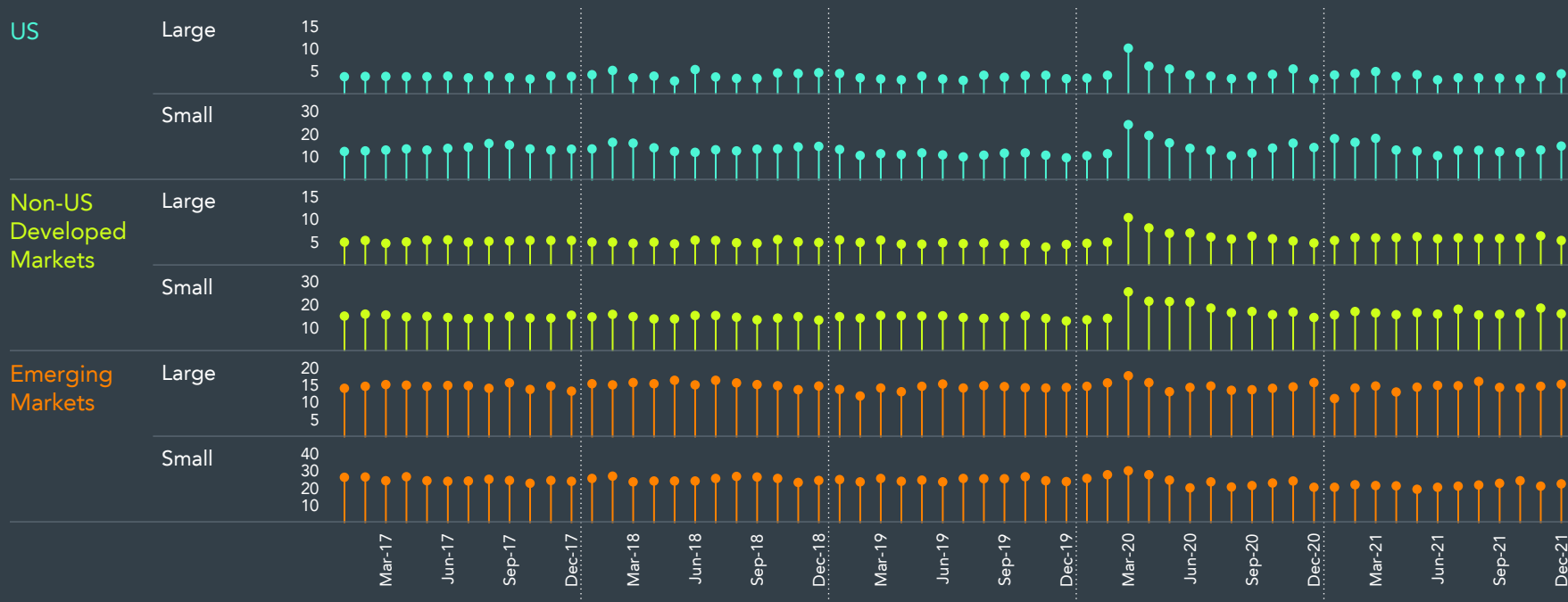
Past performance is no guarantee of future results.

The "Median Peer Trading Costs" data provided on this slide is copyrighted by Virtu ITG LLC or its affiliates and may not be copied, displayed, or transmitted in any form without prior written permission. Many factors influence transaction costs including order size, volatility, and spread. Virtu's peer universe includes a variety of firm types trading orders of all sizes in various market conditions. See Appendix "Historical All Country Daily Premiums" and "Index Descriptions" for additional information.

Relative Price Advantages of Flexible Trading



Dimensional price advantage in equity trades vs. demanding immediacy¹ (bps), 2017–2021



Past performance is no guarantee of future results.

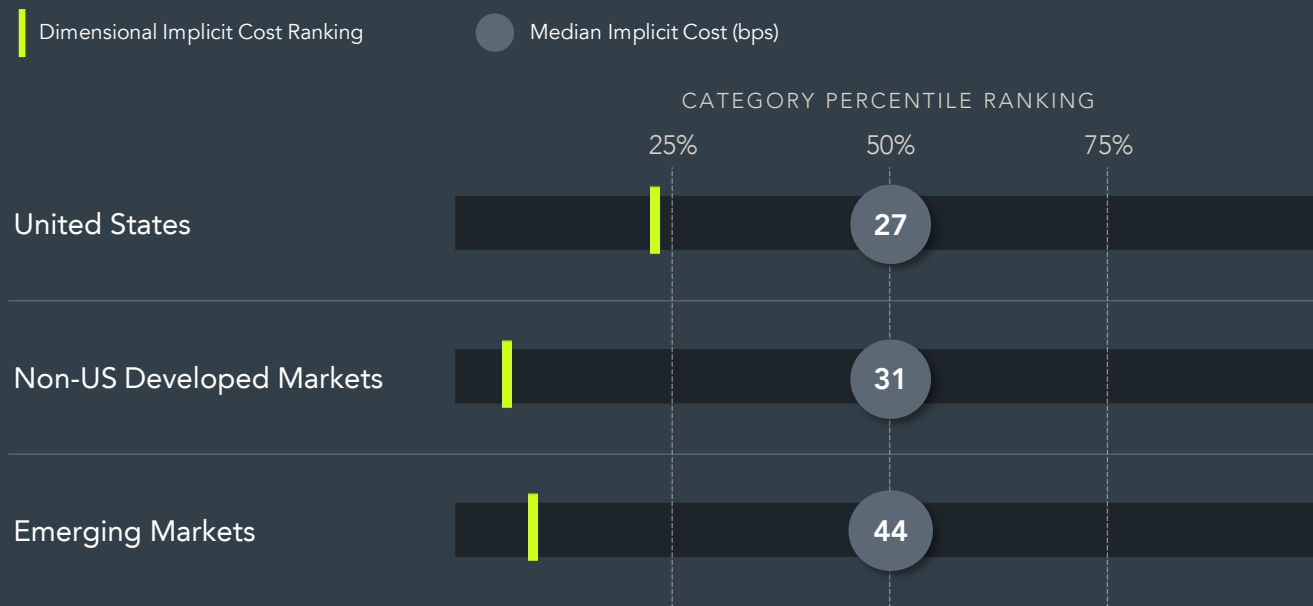
1. Price advantages estimated relative to demanding immediacy, represented by an approach that sells at the bid and buys at the offer (SBBO).

Monthly average price advantages over SBBO in basis points (bps). Source: Dimensional. Small cap is defined as approximately the bottom 8% of market cap within the US, bottom 12.5% of market cap within each non-US developed market country, and bottom 15% of market cap within each emerging market country. Small cap stocks with the lowest profitability and lowest book-to-market ratios are excluded. For more information and a description of the methodology used, see Jerry Liu and Ryan J. Wiley, "Global Trading Price Advantages of Flexible Equity Portfolios," June 2021.

Dimensional Implicit Costs Relative to Peers



Virtu Post-Trade Analytics™—Peer Trade Cost Analysis, one year ending December 31, 2022



- Trading costs negatively impact returns
- Lower implicit costs contributes to lower total trading costs
- Dimensional uses both third party and internally developed benchmarks to evaluate the implicit costs of trading.

Past performance is not a guarantee of future results.

Date range reflects most recent data available. Ranking provided by Virtu. Ranking from 1-100% where 1 is lowest implicit cost and 100 is highest implicit cost. The data provided on this slide is copyrighted by Virtu ITG LLC or its affiliates and may not be copied, displayed, or transmitted in any form without prior written permission. Many factors influence transaction cost including order size, volatility, and spread. Virtu's peer universe includes a variety of firm types trading orders of all sizes in various market conditions. US peer data includes firms trading more than USD\$100mm in the US during the period.

Takeaways

Evaluate Systematic Managers Holistically

Research | Design | Portfolio Management | Trading

Evaluate Simulations Skeptically

Purpose | Assumptions | Justifications | Applicability

Evaluate Performance Comprehensively

Positioning | Premium Capture | Consistency

Appendix

Daily Fixed Income Process

| Expected Return Analysis | Risk Management | Flexible Trading |
|---|---|--|
| Calculate expected returns | Assess current credit quality and liquidity from market-based sources | Locate bonds across all available sources of liquidity |
| Identify targeted curves and segments | Account for short-term equity returns and firm news | Prioritize price in trade execution while maintaining flexibility on quantity and time |
| Evaluate current holdings and opportunities to improve expected returns | | |

Regression Tests

Monthly Fama-MacBeth regressions of corporate bond returns on test variables, Global ex USD Sample, 2000–2020

| | | Total Return | | | Total Return – Forward Rate | | |
|------------------------------|-------------------------------------|--------------|--------|----------------|-----------------------------|--------|----------------|
| | | Coefficient | t-Stat | R ² | Coefficient | t-Stat | R ² |
| Bond-Level Characteristics | Forward Rate | 1.13 | 2.95 | 0.19 | — | — | — |
| | Default-Adj Credit Spread ("Value") | 0.11 | 3.40 | 0.11 | 0.03 | 1.06 | 0.09 |
| | Short-Term Bond Return | 0.01 | 0.38 | 0.12 | 0.01 | 0.38 | 0.12 |
| | Bond Momentum | 0.07 | 1.63 | 0.11 | 0.07 | 1.67 | 0.11 |
| | Short-Term Credit Premium | 0.02 | 0.45 | 0.11 | 0.02 | 0.56 | 0.10 |
| | Credit Momentum | 0.04 | 0.95 | 0.10 | 0.05 | 1.27 | 0.10 |
| Issuer-Level Characteristics | Market Capitalization | -0.01 | -1.16 | 0.02 | 0.01 | 1.15 | 0.02 |
| | Total Debt Outstanding | 0.00 | -1.04 | 0.01 | 0.00 | 0.22 | 0.01 |
| | Book-to-Market | 0.00 | -0.38 | 0.01 | -0.01 | -1.16 | 0.01 |
| | Profitability | 0.00 | 0.56 | 0.01 | 0.01 | 1.12 | 0.01 |
| | Leverage | 0.00 | -0.11 | 0.01 | 0.00 | -1.02 | 0.01 |
| | Distance to Default | 0.00 | 0.12 | 0.02 | 0.01 | 0.95 | 0.01 |
| | Short-Term Equity Return | 0.03 | 5.41 | 0.01 | 0.03 | 5.67 | 0.01 |
| | Equity Momentum | 0.02 | 2.62 | 0.01 | 0.02 | 3.28 | 0.01 |

Past performance, including hypothetical performance, is no guarantee of future results.

Filters were applied to data retroactively and with the benefit of hindsight.

Source: Bond data are from Bloomberg and include constituents of the Global Aggregate Index and Global High Yield Bond Index. Equity data are from Bloomberg Global Stock database and CRSP. The sample period is January 2000 to December 2020. The table shows results from monthly cross-sectional Fama-MacBeth regressions of corporate bond returns on test variables. See "Alternative Variables and Expected Bond Returns" for additional information on the variables used.

Corporate Bond Data Overview

Monthly bond data sourced from Bloomberg Global Aggregate and Global High Yield Universe

- Data cover 2000–2020
 - Investment Grade and High Yield (Credit Rating AAA–B)
 - Duration between 1 and 10 years
 - Excluding bonds with optionality (except Make Whole Call)
 - 12 Currencies, 22 Countries
-

Monthly stock data sourced from Bloomberg Global Stock Database

- Linked to Bloomberg Global Stock Database to obtain equity characteristics of a bond's issuer
- Restricted to mappings that ensure meaningful link between security and issuer equity characteristics
- On average, 85% of market value (84% of bond observations) can be mapped to a publicly listed entity

Alternative Variables and Expected Bond Returns

Overview

Bond-level Characteristics

Forward Rate: Forward Rate of the corporate bond

Default-Adj Credit Spread ("Value"): Residual from monthly cross-sectional regressions of credit spread on distance to default

Short-Term Bond Return: Total bond return over the past month

Bond Momentum: Total bond return over the past six months, excluding the most recent month

Short-Term Credit Premium: Bond return in excess of matching Treasury over the past month

Credit Momentum: Bond return in excess of matching Treasury over the last six months, excluding the most recent month

Issuer-level Characteristics

Market Capitalization: Issuer equity market capitalization

Total Public Debt Outstanding: Total market value of bonds issued by a bond's issuer

Book-to-Market: Issuer ratio of book equity to market capitalization

Profitability: Issuer operating income before depreciation and amortization minus interest expense divided by book equity

Leverage: Issuer ratio of net debt to (net debt + equity market capitalization)

Distance to Default: Model-derived measure of issuer's default risk (Merton 1974, Bharath and Shumway 2008)

Short-Term Equity Return: Issuer stock return over the past month

Equity Momentum: Issuer stock return over the past six months, excluding the most recent month

Historical All Country Daily Premiums



From 1975 to 1988, the market premium is the arithmetic average of the weighted average returns of the Fama/French US Total Market Research Index and the Fama/French International Market Index minus the annual One-Month US Treasury Bills returns. Starting in 1989, the weighted average returns of the Fama/French Emerging Markets Index are included.

The size premium is the arithmetic average of the annual small cap returns minus annual large cap returns. Pre-1989, annual small cap returns are from the Dimensional Global Small Index. Starting in 1989, the weighted average returns of the Dimensional Emerging Markets Small Index are included. Annual large cap returns are from the MSCI World Index (gross div) pre-1989 and the MSCI ACWI Index (gross div) post-1989.

From 1975 to 1988, the relative price premium is the arithmetic average of the weighted average returns of the Fama/French US Value Research Index and the Fama/French International Value Index minus the weighted average returns of the Fama/French US Growth Research Index and the Fama/French International Growth Index. Starting in 1989, the weighted average returns of the Fama/French Emerging Markets Value Index and the Fama/French Emerging Markets Growth Index are included.

In 1990, the profitability premium is the arithmetic average of the weighted average returns of the Fama/French US High Profitability Index and the Fama/French International High Profitability Index minus the weighted average returns of the Fama/French US Low Profitability Index and the Fama/French International Low Profitability Index. Starting in 1991, the weighted average returns of the Fama/French Emerging Markets High Profitability Index and Fama/French Emerging Markets Low Profitability Index are included. Profitability is measured as operating income before depreciation and amortization minus interest expense, scaled by book.

“One-Month Treasury Bills” is the IA SBBI US 30 Day TBill TR USD, provided by Ibbotson Associates via Morningstar Direct. Dimensional indices use CRSP, Compustat and Bloomberg data. S&P data © 2023 S&P Dow Jones Indices LLC, a division of S&P Global. All rights reserved. Fama/French indices provided by Ken French. Eugene Fama and Ken French are members of the Board of Directors of the general partner of, and provide consulting services to, Dimensional Fund Advisors LP. The Dimensional and Fama/French Indices represent academic concepts that may be used in portfolio construction and are not available for direct investment or for use as a benchmark. Index returns are not representative of actual portfolios and do not reflect costs and fees associated with an actual investment. See “Index Descriptions” in the appendix for descriptions of Dimensional and Fama/French index data.

Returns do not represent actual portfolios and do not reflect costs and fees associated with an actual investment. Daily premiums are calculated by dividing the annual premiums by 252, the approximate number of trading days in one year, back to 1970. Diversification does not protect against loss in declining markets.

The Dimensional Indices have been retrospectively calculated by Dimensional Fund Advisors LP and did not exist prior to their index inception dates. Accordingly, the results shown during the periods prior to each Index's index inception date do not represent actual returns of the Index. Other periods selected may have different results, including losses. Backtested index performance is hypothetical and is provided for informational purposes only to indicate historical performance had the index been calculated over the relevant time periods. Backtested performance results assume the reinvestment of dividends and capital gains. Index descriptions for the Dimensional and Fama/French indices available upon request.

Index Descriptions



Fama/French Total US Market Research Index: July 1926–present: Fama/French Total US Market Research Factor + One-Month US Treasury Bills. Source: Ken French Website.

Fama/French US Value Research Index: Provided by Fama/French from CRSP securities data. Includes the lower 30% in price-to-book of NYSE securities (plus NYSE Amex equivalents since July 1962 and Nasdaq equivalents since 1973).

Fama/French US Growth Research Index: Provided by Fama/French from CRSP securities data. Includes the higher 30% in price-to-book of NYSE securities (plus NYSE Amex equivalents since July 1962 and Nasdaq equivalents since 1973).

Fama/French US Small Value Research Index: Provided by Fama/French from CRSP securities data. Includes the lower 30% in price-to-book of NYSE securities (plus NYSE Amex equivalents since July 1962 and Nasdaq equivalents since 1973) that have smaller market capitalization than the median NYSE company.

Fama/French US Large Growth Research Index: Provided by Fama/French from CRSP securities data. Includes the higher 30% in price-to-book of NYSE securities (plus NYSE Amex equivalents since July 1962 and Nasdaq equivalents since 1973) that have larger market capitalization than the median NYSE company.

Fama/French US High Profitability Index: July 1963–present: Fama/French US High Profitability Index. Courtesy of Fama/French from CRSP and Compustat securities data. Includes all stocks in the upper 30% operating profitability range of NYSE eligible firms; rebalanced annually in June. OP for June of year t is annual revenues minus cost of goods sold, interest expense, and selling, general, and administrative expenses divided by book equity for the last fiscal year end in $t-1$. Fama/French and multifactor data provided by Fama/French.

Fama/French US Low Profitability Index: July 1963–present: Fama/French US Low Profitability Index. Courtesy of Fama/French from CRSP and Compustat securities data. Includes all stocks in the lower 30% operating profitability range of NYSE eligible firms; rebalanced annually in June. OP for June of year t is annual revenues minus cost of goods sold, interest expense, and selling, general, and administrative expenses divided by book equity for the last fiscal year end in $t-1$. Fama/French and multifactor data provided by Fama/French.

Fama/French International Market Index: January 1975–present: Fama/French International Market Index. Source: Ken French website. Simulated from MSCI and Bloomberg data.

Fama/French International Value Index: January 1975–present: Fama/French International Value Index. Simulated strategy of international developed countries with securities in the lower 30% price-to-book range. Source: Ken French website. Simulated from MSCI and Bloomberg data.

Fama/French International Growth Index: January 1975–present: Fama/French International Growth Index. Simulated strategy of international developed countries with securities in the higher 30% price-to-book range. Source: Ken French website. Simulated from MSCI and Bloomberg data.

Fama/French International High Profitability Index: July 1990–present: Fama/French International High Profitability Index. Courtesy of Fama/French from Bloomberg securities data. Includes stocks in the upper 30% operating profitability range in each region; companies weighted by float-adjusted market cap; rebalanced annually in June. OP for June of year t is annual revenues minus cost of goods sold, interest expense, and selling, general, and administrative expenses divided by book equity for the last fiscal year end in $t-1$. Fama/French and multifactor data provided by Fama/French.

Fama/French International Low Profitability Index: July 1990–present: Courtesy of Fama/French from Bloomberg securities data. Includes stocks in the lower 30% operating profitability range in each region; companies weighted by float-adjusted market cap; rebalanced annually in June. OP for June of year t is annual revenues minus cost of goods sold, interest expense, and selling, general, and administrative expenses divided by book equity for the last fiscal year end in $t-1$. Fama/French and multifactor data provided by Fama/French.

Results shown during periods prior to each index's index inception date do not represent actual returns of the respective index. Other periods selected may have different results, including losses. Backtested index performance is hypothetical and is provided for informational purposes only to indicate historical performance had the index been calculated over the relevant time periods. Backtested performance results assume the reinvestment of dividends and capital gains. Profitability is measured as operating income before depreciation and amortization minus interest expense scaled by book. Eugene Fama and Ken French are members of the Board of Directors of the general partner of, and provide consulting services to, Dimensional Fund Advisors LP.

Important Disclosures



Simulated returns-based model/back-tested performance. These are not live strategies managed by Dimensional Fund Advisors LP or any of its affiliates, including Dimensional Fund Advisors Ltd., Dimensional Ireland Limited, DFA Australia Limited, Dimensional Fund Advisors Canada ULC, Dimensional Fund Advisors Pte. Ltd., Dimensional Japan Ltd., or Dimensional Hong Kong Limited. The performance was achieved with the retroactive application of a model designed with the benefit of hindsight; it does not represent actual investment performance. Back-tested model performance is hypothetical (it does not reflect trading in actual accounts) and is provided for informational purposes only. The securities held in the model may differ significantly from those held in client accounts. Model performance may not reflect the impact that economic and market factors might have had on the advisor's decision making if the advisor were actually managing client money. These strategies were not available for investment in the time periods depicted. Actual management of these types of simulated strategies may result in lower returns than the back-tested results achieved with the benefit of hindsight. Past performance (including hypothetical past performance) does not guarantee future or actual results. The simulated performance shown is "gross performance," which includes the reinvestment of dividends but does not reflect the deduction of investment advisory fees and other expenses.

Testing the Valuation Equation: Descriptions and Important Information

US Large and US Small: 1963–2021

Source: CRSP and Compustat data calculated by Dimensional. Fama/French data provided by Fama/French. Includes stocks in the Fama/French US Total Market Research Index. Stocks are sorted on price-to-book into three portfolios, each representing one-third of the market. Similarly, stocks are sorted on profitability into three portfolios, each representing one-third of the market. Utilities are excluded from Dimensional analysis. From the intersections of the three portfolios formed on price-to-book and the three portfolios formed on profitability, we form nine profitability/price-to-book portfolios. Portfolios are rebalanced annually in June when index is rebalanced.

Non-US Developed: 1975–2021

Source: Bloomberg data calculated by Dimensional. Fama/French data provided by Fama/French. Includes stocks in the Fama/French International Market Index prior to 1990 and the Fama/French Developed ex US Market Index thereafter. Stocks in each non-US developed market country are sorted on price-to-book into three portfolios, each representing one-third of the aggregate market capitalization of that country. Similarly, stocks are sorted on profitability into three portfolios, each representing one-third of the aggregate market capitalization of that country. Stocks with negative or missing price-to-book or missing profitability are excluded from Dimensional analysis. Companies with total market cap smaller than 10 million USD are excluded from Dimensional analysis since 1990. From the intersections of the three portfolios formed on price-to-book and the three portfolios formed on profitability, we form nine profitability/price-to-book portfolios. Portfolios are rebalanced annually in December prior to 1990 and June thereafter when index is rebalanced.

Emerging Markets: 1989–2021

Source: Bloomberg data calculated by Dimensional. Fama/French data provided by Fama/French. Includes stocks in the Fama/French Emerging Market Index. Stocks in each emerging market country are sorted on price-to-book into three portfolios, each representing one-third of the aggregate market capitalization of that country. Similarly, stocks are sorted on profitability into three portfolios, each representing one-third of the aggregate market capitalization of that country. Stocks with negative or missing price-to-book or missing profitability are excluded from Dimensional analysis. Companies with total market cap smaller than 10 million USD are excluded from Dimensional analysis since 1994. From the intersections of the three portfolios formed on price-to-book and the three portfolios formed on profitability, we form nine profitability/price-to-book portfolios. Portfolios are rebalanced annually in June when index is rebalanced.

Index Descriptions:

Fama/French Total US Market Research Index: July 1926–present: Fama/French Total US Market Research Factor + One-Month US Treasury Bills. Source: Ken French Website.

Fama/French International Market Index: January 1975–present: Fama/French International Market Index. Source: Ken French website. Simulated from MSCI and Bloomberg data.

Fama/French Developed ex US Market Index: July 1990–present: Fama/French Developed ex US Market Index. Rebalanced annually in June. Includes all stocks with market equity data as of the rebalance date. Source: Ken French website.

Fama/French Emerging Markets Index: July 1989–present: Fama/French Emerging Markets Index. Courtesy of Fama/French from Bloomberg and IFC securities data. Companies weighted by float-adjusted market cap; rebalanced annually in June. Fama/French and multifactor data provided by Fama/French.

Results shown during periods prior to each index's index inception date do not represent actual returns of the respective index. Other periods selected may have different results, including losses. Backtested index performance is hypothetical and is provided for informational purposes only to indicate historical performance had the index been calculated over the relevant time periods. Backtested performance results assume the reinvestment of dividends and capital gains. Profitability is measured as operating income before depreciation and amortization minus interest expense scaled by book. Eugene Fama and Ken French are members of the Board of Directors of the general partner of, and provide consulting services to, Dimensional Fund Advisors LP.

Dimensional Research

How Targeting the Size, Value, and Profitability Premiums Can Improve Retirement Outcomes

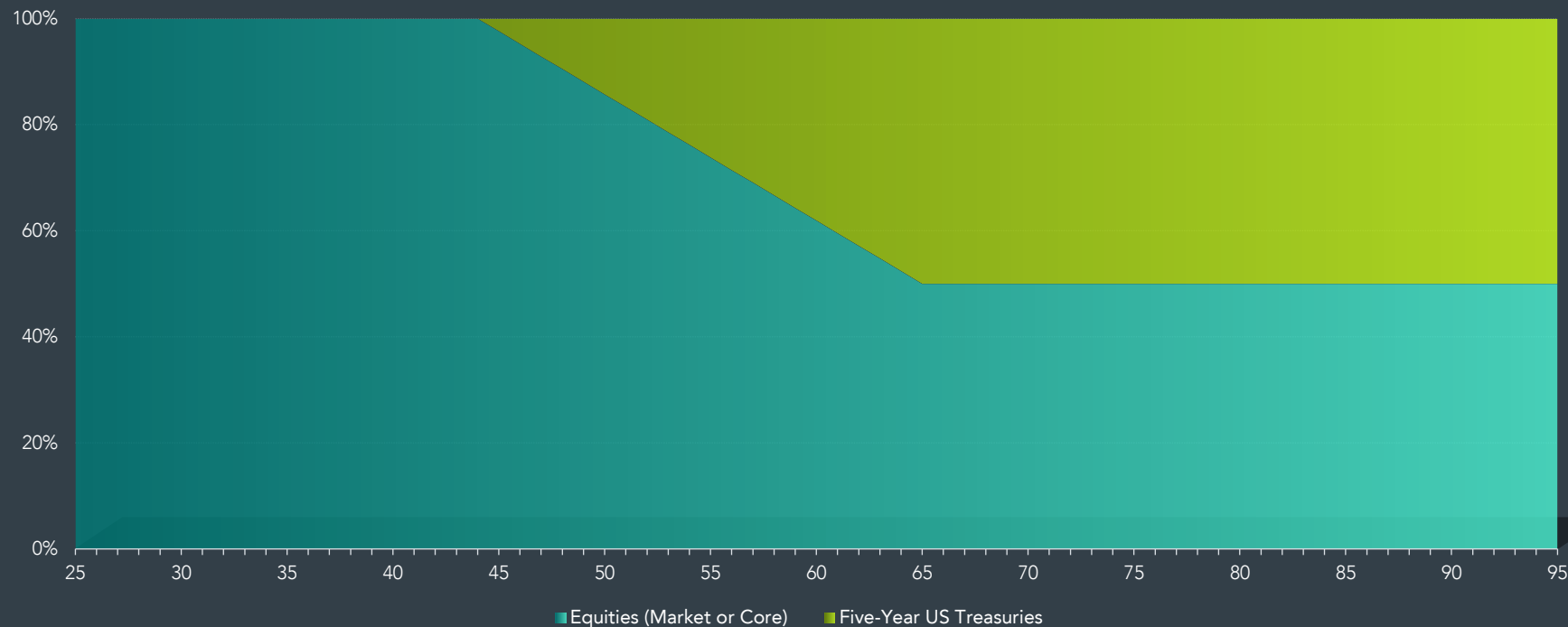
Mathieu Pellerin, Senior Researcher and Vice President

June 7, 2023

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Glidepath

Dynamic asset allocation used in the study



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

The Contenders



Real returns (June 1927 to December 2022)

| | CRSP 1-10 (Market) | Dimensional US Adjusted Market 1 (Core) |
|-------------------------------|-----------------------|--|
| Average return (historical) | 8.1% | 9.1% |
| Average return (conservative) | 5.0% | 6.0% |
| Standard deviation | 18.5% | 19.5% |
| Premium vs. market | — | 1.0% |
| Tracking error vs. market | — | 2.6% |

The Dimensional US Adjusted Market 1 Index reflects the performance of a diversified equity allocation with an integrated and balanced emphasis on size, value, and profitability.

In USD. Real monthly returns are $(1 + \text{Monthly return}) / (1 + \text{Monthly Growth in CPI}) - 1$. Current performance may be higher or lower than the performance shown. Performance may increase or decrease as a result of currency fluctuations. CRSP data provided by the Center for Research in Security Prices, University of Chicago. Dimensional US Adjusted Market 1 Index compiled by Dimensional. Inflation adjustments are based on the US CPI, sourced from the Bureau of Labor Statistics. Indices are not available for direct investment; therefore, their performance does not reflect the expenses associated with the management of an actual portfolio. Performance data shown represents past performance and is not a guarantee of future results. The Dimensional indices represent academic concepts that may be used in portfolio construction and are not available for direct investment or for use as a benchmark. See "Index Descriptions" in the appendix for descriptions of the Dimensional index data. FOR RESEARCH AND EDUCATIONAL PURPOSES. See appendix "Retirement Outcomes Methodology Summary".

Results

Distribution of Assets at Age 65

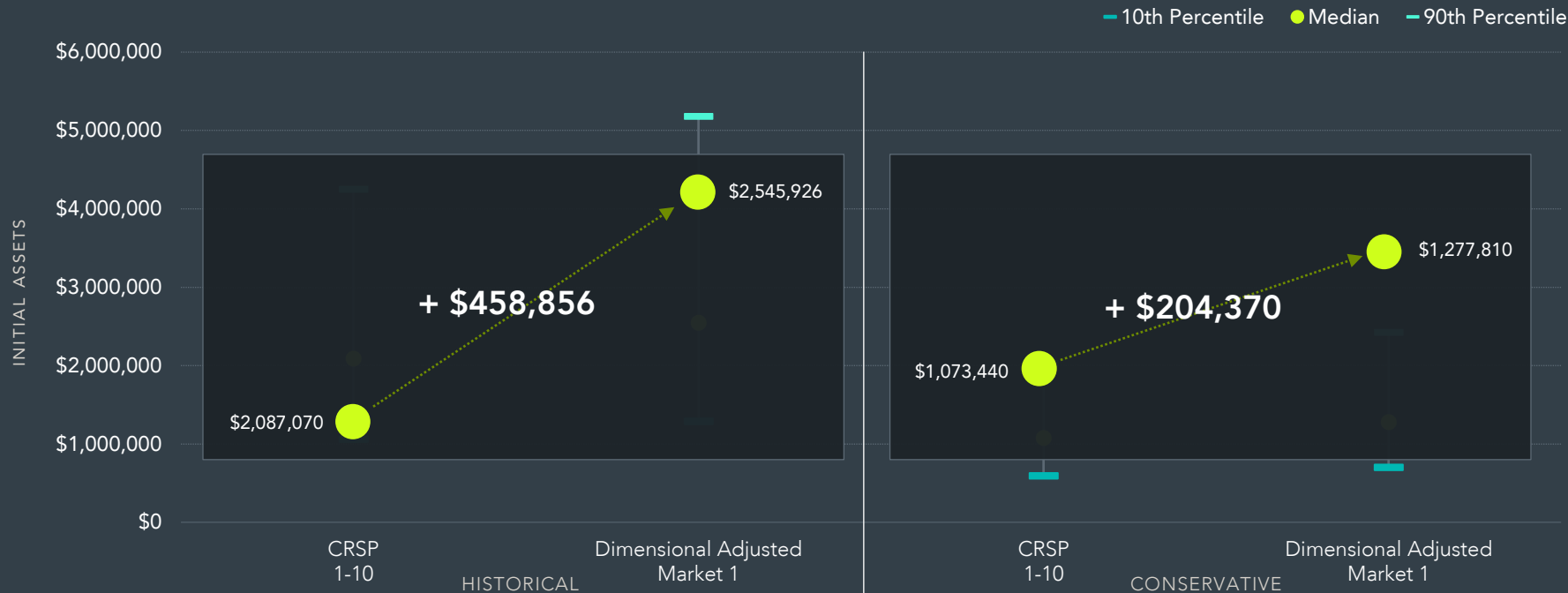
Based on 40 annual contributions of \$12,500 starting at age 25



In USD. Simulation results are based on the first of 480 observations (40 years) of 100,000 sequences of 840 bootstrapped monthly, inflation-indexed returns—see Appendix slide for a description of the sample data, data sources, portfolio construction, and spending rules. Assets at the beginning of retirement are based on 480 monthly contributions of \$1,042 (\$12,500 per year) during the accumulation phase. All numbers are inflation-adjusted using the US CPI. Results are based on a portfolio that incorporates equities and fixed income according to the glide path shown on the “Glidepath” slide. The historical distribution assumes real expected stock returns of 8.1% vs. 5.0% under the conservative distribution. The projections or other information generated by bootstrapped samples regarding the likelihood of various investment outcomes are hypothetical in nature, do not reflect actual investment results, and are not guarantees of future results. Results will vary with each use and over time. FOR RESEARCH AND EDUCATIONAL PURPOSES. See appendix “Retirement Outcomes Methodology Summary”.

Distribution of Assets at Age 65

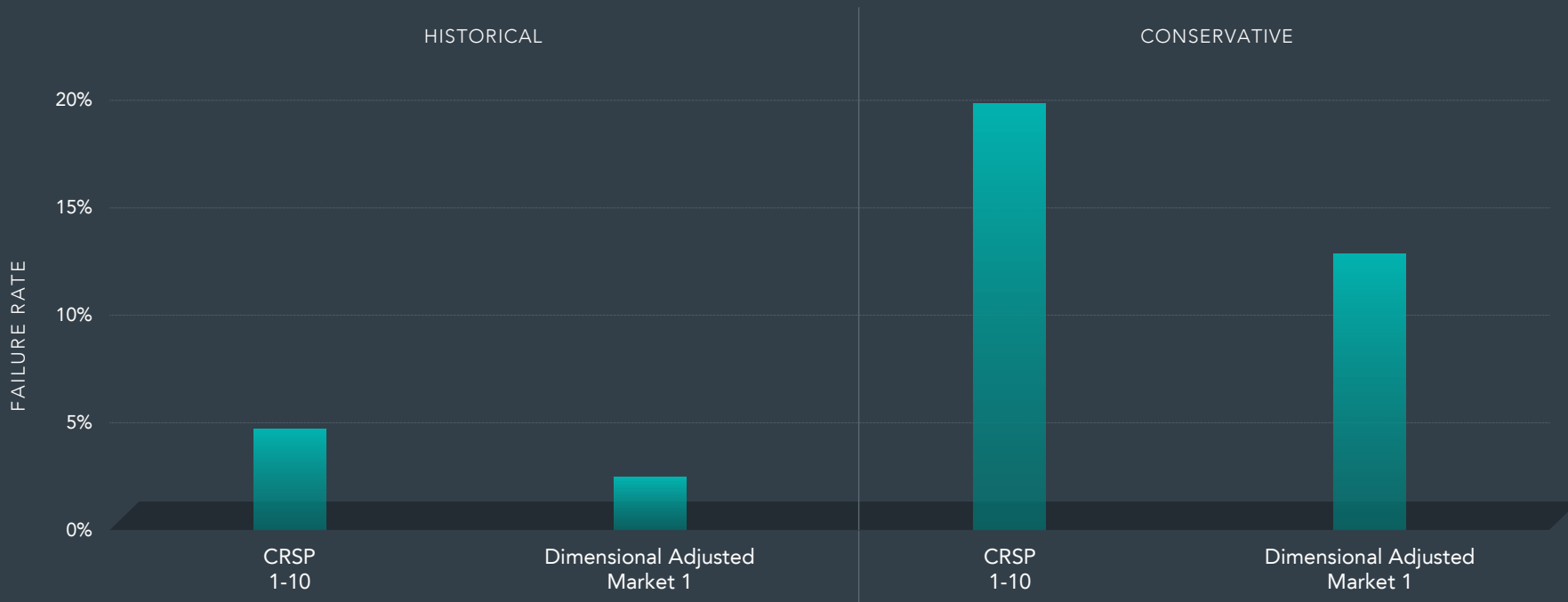
Based on 40 annual contributions of \$12,500 starting at age 25



In USD. Simulation results are based on the first of 480 observations (40 years) of 100,000 sequences of 840 bootstrapped monthly, inflation-indexed returns—see Appendix slide for a description of the sample data, data sources, portfolio construction, and spending rules. Assets at the beginning of retirement are based on 480 monthly contributions of \$1,042 (\$12,500 per year) during the accumulation phase. All numbers are inflation-adjusted using the US CPI. Results are based on a portfolio that incorporates equities and fixed income according to the glide path shown in Exhibit 1. The historical distribution assumes real expected stock returns of 8.1% vs. 5.0% under the conservative distribution. The projections or other information generated by bootstrapped samples regarding the likelihood of various investment outcomes are hypothetical in nature, do not reflect actual investment results, and are not guarantees of future results. Results will vary with each use and over time. FOR RESEARCH AND EDUCATIONAL PURPOSES. See appendix "Retirement Outcomes Methodology Summary".

Failure Rates in Retirement

30-year spending horizon and 4% spending rule



Failure probability based on a 30-year retirement. Simulation results are based on 100,000 sequences of 360 bootstrapped monthly, inflation-indexed returns using the US CPI—Appendix slide for a description of the sample data, portfolio construction, and spending rules. Results are based on a portfolio that incorporates equities and fixed income according to the glide path shown in Exhibit 1. The historical distribution assumes real expected stock returns of 8.1% vs. 5.0% under the conservative distribution. The projections or other information generated by bootstrapped samples regarding the likelihood of various investment outcomes are hypothetical in nature, do not reflect actual investment results, and are not guarantees of future results. Results will vary with each use and over time. FOR RESEARCH AND EDUCATIONAL PURPOSES. See appendix "Retirement Outcomes Methodology Summary"

Main Takeaways

- Broadly diversified equity portfolios with a moderate emphasis on size, value, and profitability can help increase retirement assets, sustain retirement income longer, and lead to larger bequests.
- A moderate amount of tilting can have a meaningful impact.
- The study was carried out using US data, but the results are relevant internationally. No evidence that the premiums are weaker or stronger in particular regions.
- The results are potentially relevant even for investors who use combinations of portfolios (e.g., 90% broad market + 10% SCV) rather than core.

Appendix

Retirement Outcomes Methodology Summary



We consider a hypothetical investor who retires at age 65 and spends until age 95 according to a 4% spending rule. Retirement spending is 4% of the initial balance at retirement. Spending remains constant in inflation-adjusted terms through retirement. The investor withdraws the spending amount at the beginning of each month. The balance then evolves according to portfolio returns. If the balance amount hits zero, we treat this as a failure.

All the returns used in the simulations are inflation-adjusted using the US CPI.

Portfolio returns are based on a constant, 50/50 split between stocks and bonds. The market portfolio is proxied by the CRSP Deciles 1–10 Index, while the core portfolio is proxied by Dimensional US Adjusted Market 1 Index. Five-year Treasury notes proxy for bond performance. The sample period runs from June 1927 to December 2022.

For each simulated retirement, we draw 30-year (360-month) return histories from our sample. We use block bootstrap with a mean block size of 10 years (120 months) to sample inflation-adjusted annual returns.

We bootstrap returns from the historical distribution and a conservative distribution. The conservative distribution is obtained by subtracting 1.65 times the standard error ($1.65 \times 1.89\% = 3.1\%$) of the average stock return from the historical average (8.1%). This is equivalent to assuming that the long-run inflation-adjusted equity return is 5.0%, which corresponds to the fifth percentile of the estimated distribution of the average historical return.

The projections or other information generated by bootstrapped samples regarding the likelihood of various investment outcomes are hypothetical in nature, do not reflect actual investment results, and are not guarantees of future results. Results will vary with each use and over time.

The full paper is publicly available [on SSRN](#) (ID 4425738)

Index Descriptions



Dimensional US Adjusted Market 1 Index

June 1927–December 1974: Dimensional US Adjusted Market 1 Index composition: Targets all the securities in the eligible market with an emphasis on companies with smaller capitalization and lower relative price. The eligible market is composed of securities of US companies traded on the NYSE, NYSE MKT (formerly AMEX), and Nasdaq Global Market. Exclusions: non-US companies, REITs, UITs, and investment companies. Source: CRSP and Compustat.

January 1975–present: Dimensional US Adjusted Market 1 Index composition: Targets all the securities in the eligible market with an emphasis on companies with smaller capitalization, lower relative price, and higher profitability, excluding those with the lowest profitability and highest relative price within the small cap universe. The index also excludes those companies with the highest asset growth within the small cap universe. Profitability is defined as operating income before depreciation and amortization minus interest expense divided by book equity. Asset growth is defined as change in total assets from the prior fiscal year to current fiscal year. The eligible market is composed of securities of US companies traded on the NYSE, NYSE MKT (formerly AMEX), and Nasdaq Global Market. Exclusions: non-US companies, REITs, UITs, and investment companies. Source: CRSP and Compustat.

The Dimensional US Adjusted Market 1 Index has been retrospectively calculated by Dimensional Fund Advisors and did not exist prior to March 1, 2007. Accordingly, the results shown during the periods prior to March 1, 2007, do not represent actual returns of the index. The index monthly returns are computed as the simple average of the monthly returns of 12 subindices, each one reconstituted once a year at the end of each month of the year. The index is unmanaged and is not subject to fees and expenses typically associated with managed accounts or investment funds. Investments cannot be made directly in an index. The calculation methodology for the Dimensional US Adjusted Market 1 Index was amended on January 1, 2014, to include profitability as a factor in selecting securities for inclusion in the index. The calculation methodology for the Dimensional US Adjusted Market 1 Index was amended in December 2019 to include asset growth as a factor in selecting securities for inclusion in the index.

Actual returns may be lower. The Dimensional indices represent academic concepts that may be used in portfolio construction and are not available for direct investment or for use as a benchmark. Index returns are not representative of actual portfolios and do not reflect costs and fees associated with an actual investment. Other periods selected may have different results, including losses. Backtested index performance is hypothetical and is provided for informational purposes only to indicate historical performance had the index been calculated over the relevant time periods. Backtested performance results assume the reinvestment of dividends and capital gains.

Disclosures



Risks

Investments involve risks. The investment return and principal value of an investment may fluctuate so that an investor's shares, when redeemed, may be worth more or less than their original value. Past performance, including simulated performance, is not a guarantee of future results. There is no guarantee strategies will be successful.

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

Diversification does not eliminate the risk of market loss.

CRSP data provided by the Center for Research in Security Prices, University of Chicago. Five-year US Treasury returns sourced from Morningstar. Dimensional US Adjusted Market 1 Index compiled by Dimensional. Inflation adjustments are based on the US CPI, sourced from the Bureau of Labor Statistics.