S&P Dow Jones Indices

A Division of S&P Global

S&P STRIDE Index Series

Methodology

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Introduction

Index Objective and Highlights

The S&P Shift To Retirement Income and Decumulation (STRIDE) Index Series comprises thirteen multi-asset class indices of indices, each corresponding to a particular target retirement date. The sub-index representation of each index is based on a pre-determined life-cycle glide-path. Each index is fully investable, with varying levels of exposure to equities, nominal fixed income securities, and inflation-adjusted bonds.

The S&P STRIDE Index Series measures the performance of a strategy that is designed to support a hedged stream of inflation-adjusted retirement income. The index series includes individual indices with specific target date years in five-year increments (vintages). Each index vintage covers a full life cycle of accumulation (during what are generally considered working years), and decumulation in retirement years. Beginning 20 years before each target date, the indices gradually re-allocate some of their weight from equity and nominal fixed income sub-indices to Treasury Inflation Protection Securities (TIPS) sub-indices. The duration of the combined (TIPS) sub-indices is matched monthly to the duration of a hypothetical retirement income cash flow stream that begins at the target date and lasts for twenty five years.

Most target date indices have a glide-path – an asset allocation which becomes more conservative as one approaches retirement. The S&P STRIDE Index Series has a three-phased glide-path consisting of:

1. **Accumulation.** This consists of a conventional target date glide-path (stock and nominal bond indices).
2. **Transition.** The index weight is gradually shifted from the target date glide-path to a pool of constituents that secure real future income.
3. **Decumulation.** The income producing constituents are divested, modelling retirement income cash flows.

Index Family

S&P STRIDE Glide-Path Series. The Glide-Path Series rebalances back to the target weights of all asset classes for each index vintage.

S&P STRIDE TIPS-Lockbox Series. The allocations to TIPS indices are never reduced for purposes of index rebalancing. Once allocations to TIPS indices have commenced within each index vintage, the TIPS-Lockbox Series only rebalances between equities and nominal bonds to bring them closer to their glide-path weights but does not reduce the weight in the TIPS indices.

For each of the above series, the following index vintages are calculated:

- 2005
- 2010
- 2015
- 2020
- 2025
- 2030
- 2035
- 2040
- 2045
- 2050
- 2055
- 2060
- 2065

New far-dated target date indices will launch at five year intervals.

Collaboration

The S&P STRIDE Index Series is generated and published under agreements between S&P Dow Jones Indices and Dimensional Fund Advisors. In development of the S&P STRIDE Index Series, S&P Dow Jones Indices used ideas from life cycle finance and an innovative risk management approach to funding consumption in retirement. S&P Dow Jones Indices thanks Robert Merton for his pioneering work in these fields, as well as Dimensional Fund Advisors for their contributions in the development of the S&P STRIDE Index Series.

Supporting Documents

This methodology is meant to be read in conjunction with supporting documents providing greater detail with respect to the policies, procedures and calculations described herein. References throughout the methodology direct the reader to the relevant supporting document for further information on a specific topic. The list of the main supplemental documents for this methodology and the hyperlinks to those documents is as follows:

Supporting Document	URL
S&P Dow Jones Indices' Equity Indices Policies & Practices Methodology	Equity Indices Policies & Practices
S&P Dow Jones Indices' Fixed Income Policies & Practices Methodology	Fixed Income Policies & Practices

This methodology was created by S&P Dow Jones Indices to achieve the aforementioned objective of measuring the underlying interest of each index governed by this methodology document. Any changes to or deviations from this methodology are made in the sole judgment and discretion of S&P Dow Jones Indices so that the index continues to achieve its objective.

Index Construction

Index Constituents

Index constituents consist of allocations to a group of indices covering global equities, global fixed income, and U.S. inflation-linked treasury securities (TIPS). The following indices represent each of the underlying asset classes:

Asset Class	Sub-Asset Class	Benchmark Name (Bloomberg Ticker)
Equities		
Domestic Equities	U.S. All-cap	S&P Composite 1500 (SPRTR)
Foreign Equities	Developed International Equities	S&P Developed ex-U.S. BMI NTR (SPCBMIRWUUSD.NTR)
	Emerging Markets Equities	S&P Emerging Markets BMI NTR (SPCBMIREMUSD.NTR)
Fixed Income		
Nominal Bonds	U.S. Nominal Bonds	S&P U.S. Aggregate Bond (SPUSAGGT)
	International Nominal Bonds	S&P Global Developed Sovereign ex- US Bond (USD Hedged) (SPDXUSHT)
TIPS Asset Class		
Inflation-Linked Bonds	Short-term TIPS	S&P 1-5 U.S. TIPS (SPBDU4YT)
	Intermediate-term TIPS	S&P 7-10 Year U.S. TIPS (SPBDUSP0T)
	Long-term Duration TIPS	S&P 30 Year U.S. TIPS (SPBDU3ST)

For information on the indices listed in the table above, please refer to the S&P U.S. Indices Methodology, S&P Global BMI, S&P/IFCI Methodology, S&P Global Bond Indices Methodology, and the S&P U.S. TIPS Index Methodology, respectively, *available at www.spdji.com.*

Weights Computation

On a monthly basis, weights are determined for each sub-asset class. In order to achieve a U.S. home bias, a multiplier is applied to the initial calculated weights of the U.S. sub-asset class for both equities and fixed income.

For equities, the relative market capitalization weights are computed within the S&P Global BMI for the U.S., Emerging, and Developed ex-U.S. regions. The U.S. equities weight is then multiplied by the equity multiplier and final relative weights are then calculated for each region. The multiplier is set at 2 for U.S. equities.

For fixed income, the relative market capitalization weights are computed for the U.S. and Developed ex-U.S. regions. The U.S. fixed income weight is then multiplied by the fixed income multiplier and final relative weights are then calculated for each region. The multiplier is currently set at 2 for U.S. fixed income. Prior to 2009, the multiplier was 4 for U.S. fixed income, due to the fact that new constituents were not included in the S&P U.S. Aggregate Bond Index prior to January 2009.

Glide-Path

There are three phases in the index life cycle:

1. **Accumulation.** This consists of a conventional target date glide-path (stock and nominal bond indices). During this phase, corresponding from 40 years before the target date to 20 years before the target date, the overall equity allocation decreases gradually and the overall nominal bond allocation increases gradually.
2. **Transition.** The index weight is gradually shifted, as determined by market performance and a pre-determined transition slope, from the target date glide-path to a group of TIPS indices that secure real future income. This phase lasts for 20 years before the target date. During this period, the overall equity allocation continues to decline and the overall nominal bond allocation also declines from its peak down to 0%. The index weight is gradually shifted from equities and nominal bonds into the set of TIPS indices, with the index weight assigned to these indices growing from 0% to 75%.
3. **Decumulation.** Decumulation begins at the target date, at which the index weight assigned to Equity and TIPS reaches 25% and 75%, respectively. Note that a decline in Equity may result in a lower Equity total at the target date in the S&P STRIDE TIPS-Lockbox Series.

Asset Allocations at Different Ages (Percentage)					
Age	**25**	**45**	**65**	**75**	**90**
Equity	95	79	25	25	5
Nominal Bonds	5	21	0	0	0
TIPS	0	0	75	75	95

Decumulation

The monthly payout amount beginning at the target date is dynamically determined, based on the cost of the generalized retirement income liability (GRIL). Throughout the buildup to retirement, the TIPS component has hedged inflation risk and sought to manage its real duration to match that of the liability (the expected income).

Please refer to Appendix I for details about GRIL, and Appendix IV for the algorithm used in determining the monthly simulated payouts.

Index Maintenance

Rebalancing

Rebalancing is carried out on a monthly basis. In general, the rebalancing rules are based on the pre-configured asset allocations. The asset allocations reflect the impact of two investment strategies: a de-risking (glide-path) strategy, shifting from equities to fixed income, that is implemented during the accumulation phase; and a liability driven investment (LDI) strategy, shifting from equities and fixed income to TIPS, that is implemented during the transition phase.

Rebalancings are effective after the close of the last business day of the month. The rebalancing reference date is the fifth business day before the last business day of the month.[1]

In order to reduce turnover, a buffer of 2% is added to the target equities, fixed income, and TIPS allocations. Additionally, a buffer of 5% is added to each of the constituents within each asset class. For each asset class, the buffer zone is defined to be the range of allocations between the upper range (target + buffer) and the lower range (target – buffer), and likewise for the intra-asset class constituents. If the target allocation is smaller than the size of the buffer, then the upper range is set at the target allocation level and the lower range is set at 0%.

On a monthly basis, the indices are rebalanced to the target allocations if any of the three asset class allocations moved outside of its respective buffer zones. If a monthly rebalancing is carried out, then the intra-asset class rebalancing is carried out automatically. In the event that no monthly rebalancing is warranted at the asset class level, but the intra-asset class constituents within the corresponding asset class moved outside their buffer zones, then the intra-asset class constituents are rebalanced to their target levels.

For the S&P STRIDE TIPS-Lockbox Series, an additional constraint is that the index points of the TIPS assets are never reduced due to the actions of the monthly rebalancings.

Currency of Calculation and Additional Index Return Series

In addition to the indices detailed in this methodology, additional return series versions of the indices may be available, including, but not limited to: currency, currency hedged, decrement, fair value, inverse, leveraged, and risk control versions. For a list of available indices, please refer to *S&P DJI's All Indices by Methodology Report*.

For information on various index calculations, please refer to S&P Dow Jones Indices' Index Mathematics Methodology.

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[1] For historical back-casting purposes prior to the launch of the index series, both the reference date and the rebalancing date were the last business day of the month.

Index Data

Index Levels

The index levels are a function of the returns of the individual constituents in the model portfolio:

$$IndexLevel_t = IndexLevel_{t-1} \times (1 + R_s) \quad (3)$$

where:

R_s = The composite return of the model portfolio for period s, calculated as:

$$R_s = \sum_{i=1}^{M} w_{i,s} \times r_{i,s} \quad (4)$$

where:

$w_{i,s}$ = The weights of each of the M assets of the model portfolio for period s (global equities, global fixed income, short-term TIPS, intermediate-term TIPS, and long-term TIPS).

$r_{i,s}$ = The returns on each of the M assets of the model portfolio since the last rebalancing.

The weights $w_{i,s}$ are the effective weights of the individual assets, rebalanced dynamically on a monthly basis. The index level is set at 100 on December 31, 2002, except for the 2065 vintage.[2]

Two index series are calculated and supplementary related metrics are also provided to facilitate a better understanding of these measurements. A separate Cash Disbursement Allocation (CDA) is created at the beginning of the decumulation phase of the index.

Return Types

1. **Total Return Index.** The total return of the index's remaining portfolio. This index is not adjusted for withdrawals made post-target date.
2. **Net Decumulation Rate Index.** The current index level reflecting the payouts as well as market movements. It gives an indication of the remaining pool given the unique pay-out structure. For more information on the calculation of this index, please see *Appendix IV*.

Note that the Total Return Index and Net Decumulation Rate Index will be identical until decumulation. However, the respective indices for the Glide-Path and TIPS-Lockbox Series may be different from each other.

[2] The index level for the 2065 vintage is set at 100 on December 31, 2007.

Index Governance

Index Committee

The S&P STRIDE Index Series is maintained by the Factor Indices Index Committee. All committee members are full-time professional members of S&P Dow Jones Indices' staff. The committee meets regularly. At each meeting, the Committee reviews matters that may affect index constituents, statistics comparing the composition of the indices to the market, and any significant market events. In addition, the Index Committee may revise index policy covering rules for selecting constituents, treatment of dividends, share counts or other matters.

S&P Dow Jones Indices considers information about changes to its indices and related matters to be potentially market moving and material. Therefore, all Index Committee discussions are confidential.

S&P Dow Jones Indices' Index Committees reserve the right to make exceptions when applying the methodology if the need arises. In any scenario where the treatment differs from the general rules stated in this document or supplemental documents, clients will receive sufficient notice, whenever possible.

In addition to the daily governance of indices and maintenance of index methodologies, at least once within any 12-month period, the Index Committee reviews the methodology to ensure the indices continue to achieve the stated objectives, and that the data and methodology remain effective. In certain instances, S&P Dow Jones Indices may publish a consultation inviting comments from external parties.

For information on Quality Assurance and Internal Reviews of Methodology, please refer to S&P Dow Jones Indices' Equity Indices Policies & Practices Methodology.

Index Policy

Announcements

Index data is evaluated daily. Anything affecting the daily index calculation is announced to clients via an index announcement.

For more information on S&P Dow Jones Indices' announcements, please refer to the Announcement Policy.

Holiday Schedule

The S&P STRIDE Index Series is calculated daily Monday through Friday, excluding U.S. market holidays.

A complete holiday schedule for the year is available at www.spdji.com.

Rebalancing

The Index Committee may change the date of a given rebalancing for reasons including market holidays occurring on or around the scheduled rebalancing date. Any such change will be announced with proper advance notice where possible.

Unexpected Exchange Closures

For information on Unexpected Exchange Closures, please refer to S&P Dow Jones Indices' Equity Indices Policies & Practices Methodology.

Recalculation Policy

For information on the recalculation policy, please refer to S&P Dow Jones Indices' Equity Indices Policies & Practices Methodology.

For information on Calculations and Pricing Disruptions, Expert Judgment and Data Hierarchy, please refer to S&P Dow Jones Indices' Equity Indices Policies & Practices Methodology.

Contact Information

For any questions regarding an index, please contact: index_services@spglobal.com.

Index Dissemination

Index levels are available through S&P Dow Jones Indices' Web site at *www.spdji.com*, major quote vendors, numerous investment-oriented Web sites, and various print and electronic media.

Index Data

Daily constituent and index level data are available via subscription.

For product information, please contact S&P Dow Jones Indices, www.spdji.com/contact-us.

Web site

For further information, please refer to S&P Dow Jones Indices' Web site at www.spdji.com.

Appendix I

Application of Liability Driven Investing (LDI) Principles

Defined benefit retirement plans utilize LDI techniques to invest in assets that are expected to produce future income to match future liabilities. The index uses the same principles to represent a transition from wealth accumulation to the formation of a portfolio that would hypothetically support a hedged inflation-protected retirement income stream. To do so, first a generalized retirement income liability that approximates retirement income liabilities for a majority of defined contribution retirement plan participants and IRA account holders is defined.

The LDI strategy of the index is to match the duration of a generalized retirement income liability (GRIL) with the duration of the TIPS index allocation, where GRIL is defined as US$ 1 of real income per year for 25 years starting at the target date of each index vintage. The cost, or present value, of GRIL fluctuates over time as a function of prevailing real interest rates as well as the length of time its cash flows would be hypothetically realized.

Generalized Retirement Income Liability (GRIL)

The GRIL is used to establish the target duration of the TIPS portfolio, as well as the maximum income payout during the decumulation phase.

The GRIL is defined monthly as US$ 1/12 inflation-adjusted income stream starting at retirement date T and extending to approximate life expectancy plus a sixty-month buffer – currently 300 months. Its cost can be computed as the present discounted value of the future cash flow (based on the assumption that discount rates are expressed with continuous compounding).

The concept of GRIL is crucial to the design of the S&P STRIDE Index Series. The GRIL represents the target retirement income that would be distributed beginning at the target date, for a period of 300 months. The asset allocation of the S&P STRIDE Index Series evolves towards that goal, by shifting from equities and fixed income into TIPS, beginning 20 years prior to the target date, and continuing until 25 years after the target date, at which time, the index is discontinued.

Let $T_1, T_2, \ldots, T_{300}$ be the time at which the real US$ 1/12 is expected to be paid out. For an index with a target date of 2020 (targeted for an investor turning 65 years in January of 2020), T_1 would stand for January 2020, T_2 would stand for February 2020, …, and T_{300} would stand for December 2044, all at the last business day of the month. Thus, if t is the time at which the present value or cost of the GRIL is determined, find the appropriate discount rates corresponding to each of the 300 monthly cash flows, where the time to the maturity of the cash flow (in years) is given by $(T_i - t)$, where i ranges from 1 to 300. The corresponding discount rate is given by $\tilde{R}_{i,t}$. Thus, the cost of the GRIL at time t is given by:

$$P_{GRIL,t} = \sum_{i=1}^{300} \left(\frac{1}{12}\right) \times e^{-\tilde{R}_{i,t}(T_i - t)} \tag{1}$$

The duration of the GRIL at time t is given by:

$$D_{GRIL,t} = \sum_{i=1}^{300} (T_i - t) \times \frac{e^{-\tilde{R}_{i,t}(T_i - t)}}{12 * P_{GRIL,t}} \tag{2}$$

The goal is to approximate the price of a risk-free, inflation-adjusted income stream, so that the cash flow is in real dollars. It is important to note that risk in this context is not the volatility or uncertainty of nominal wealth, but the volatility and uncertainty of future real income. Therefore, the implied TIPS rate that corresponds to the expected duration of the cash flow is an appropriate discount rate (please refer to *Appendix II*).

Once the GRIL duration is calculated for a given target date, it is used to construct an allocation of TIPS indices that matches the GRIL duration. Please refer to *Appendix III* for details on the computation of the weights of the TIPS indices on a duration-matched basis.

Appendix II

Real Yield Curve

Yields of different maturities can be derived from the TIPS yields. Intermediate maturities can be linearly interpolated from the published maturities.

A zero coupon yield curve from the traded TIPS is constructed. The zero coupon curve is extended to maturities beyond the available ones. This approach gives a full set of rates $\tilde{R}_{i,t}$, that can be used to approximate the discount rates $R_{i,t}$ in equations (1) and (2).

Using the observed yields from six S&P U.S. TIPS Indices (S&P 1-5 Year U.S. TIPS Index, S&P 7-10 Year U.S. TIPS Index, S&P 10 Year U.S. TIPS Index, S&P 10-15 Year U.S. TIPS Index, S&P 15+ Year U.S. TIPS Index, and S&P 30 Year U.S. TIPS Index), the average coupons, maturities and durations of each of these indices are also retrieved. The following steps describe the procedure:

1. Construct the spot curve from the coupon-yield data
2. Interpolate the coupon yield curve from the observed data
3. Calculate coupon cash flows from the interpolated coupon yield curve
4. Strip the yield curve to get the spot curve, following the standard general methodology of bootstrapping.[3]

[3] William F. Sharpe, Gordon J. Alexander, Jeffrey V. Bailey (1998). *Investments*. Prentice Hall International. ISBN 0-13-011507-X.

Appendix III

Duration Matching

The duration matching process of TIPS Indices to reflect the duration of the GRIL is done by allocating appropriate weights to the TIPS Indices based on their durations.

A 25-year real income stream has the duration of approximately 10-12 years, on average. The price and duration of the cash flows are calculated using the entire yield curve. However, when the pricing is carried out at an earlier age, duration must be adjusted to take into account the deferred timing. Taking a 55 year old for example, the duration of the TIPS component with payments that start at age 65 is approximately 22 (= 12 + (65 - 55)) years. The section of the yield curve with maturities 10 years and beyond can be used to price the cash flow (with a duration of approximately 22 years).

An illustrative example is provided below.

In December 2014, the GRIL duration for a participant planning to retire in 2020 was approximately 20 years. The 20-year GRIL duration could be matched with an allocation of 40% to the intermediate-term TIPS index and 60% to the long-term TIPS index. An intermediate-term index has the duration of eight years and the long-term index has the duration of 28 years, such that the duration of 20 years can be allocated as follows:

$$(40\% \times 8) + (60\% \times 28) = 20 \qquad (3)$$

Allocation to the TIPS Indices is done by obtaining the durations of the following three S&P U.S. TIPS Indices: S&P 1-5 Year U.S. TIPS Index, S&P 7-10 Year U.S. TIPS Index, and S&P 30 Year U.S. TIPS Index.

Define the duration of the TIPS indices as follows:

Let d_1 = Duration of the S&P 1-5 Year U.S. TIPS Index

Let d_2 = Duration of the S&P 7-10 Year U.S. TIPS Index

Let d_3 = Duration of the S&P 30 Year U.S. TIPS Index

Define the weight of the S&P TIPS Indices as follows:

Let l_1 = Weight of the S&P 1-5 Year U.S. TIPS Index

Let l_2 = Weight of the S&P 7-10 Year U.S. TIPS Index

Let l_3 = Weight of the S&P 30 Year U.S. TIPS Index

To match the duration of the GRIL at time t, compare $D_{GRIL,t}$ with d_2:

$$\text{If } D_{GRIL,t} > d_2\text{, then } \begin{cases} l_1 = 0 \\ l_2 = \frac{(D_{GRIL,t} - d_3)}{(d_2 - d_3)} \\ l_3 = \frac{(D_{GRIL,t} - d_2)}{(d_3 - d_2)} \end{cases} \tag{4a}$$

$$\text{If } D_{GRIL,t} = d_2\text{, then } \begin{cases} l_1 = 0 \\ l_2 = 1 \\ l_3 = 0 \end{cases} \tag{4b}$$

$$\text{If } D_{GRIL,t} < d_2\text{, then } \begin{cases} l_1 = \frac{(D_{GRIL,t} - d_2)}{(d_1 - d_2)} \\ l_2 = \frac{(D_{GRIL,t} - d_1)}{(d_2 - d_1)} \\ l_3 = 0 \end{cases} \tag{4c}$$

Appendix IV

Decumulation

Beginning in January of the target date maturity year, the index will begin to divest assets in order to reflect income pay-outs. The income levels are dynamically determined, based on the cost of the GRIL for the year. Furthermore, for each of the months in the same calendar year, the monthly simulated payouts remain the same as the January payment of that year.

Income Estimates. Beginning with January of the target date, the cost of the GRIL during the decumulation phase is calculated, annually, as follows:

$$P_{GRIL,t} = \sum_{i=N(t)}^{300} \left(\frac{1}{12}\right) \times e^{-\tilde{R}_{i,t}(T_i - t)} \tag{5}$$

where:

t = The calculation date.

T_i = The month and year the i^{th} payment is made.

$\tilde{R}_{i,t}$ = The discount rate corresponding to maturity $(T_i - t)$.

$N(t)$ = The index number of T_i where T_i = *t*. For example, for the 2015 cohort, if *t* = August 31, 2015, then T_8 is the corresponding payment date. Thus *i* = 8.

The corresponding expression for the duration measure is:

$$D_{GRIL,t} = \sum_{i=N(t)}^{300} (T_i - t) \times \frac{e^{-\tilde{R}_{i,t}(T_i - t)}}{12 * P_{GRIL,t}} \tag{6}$$

The monthly simulated payout from the index may be computed as follows:

$$Monthly\ (simulated)\ Income\ (t) = \frac{Index\ Level\ (t) \times l_t}{12 * P_{GRIL,t}} \tag{7}$$

where:

l_t = The LDI weight at time t.

$P_{GRIL,t}$ = As defined in equation (5) above.

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