S&P Dow Jones Indices

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TalkingPoints

How Glass-Box Optimization Brings Transparency to Sustainability

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Motivated by the continuing need for transparency in how sustainability and climate-related objectives are incorporated into the index construction process, S&P Dow Jones Indices (S&P DJI) has developed and deployed its own glass-box optimization method across a wide range of sustainability-focused indices. The approach aims to provide risk-efficient solutions with targeted outcomes while improving the interpretability and explainability of the selection and weighting of constituents. This is achieved by ensuring the sustainability-related data is the key driver for each company's relative weight change to the underlying index. The end result is a clearer relationship between each company's resultant weight in the index and its sustainability characteristics.

1. How does S&P DJI's glass-box optimization work?

In its simplest form, the glass-box optimization method minimizes active share,[1] subject to the condition of proportional redistribution. It does this by minimizing the sum of the squared differences in constituent weights between those in the underlying benchmark, divided by each company's weight in the benchmark.

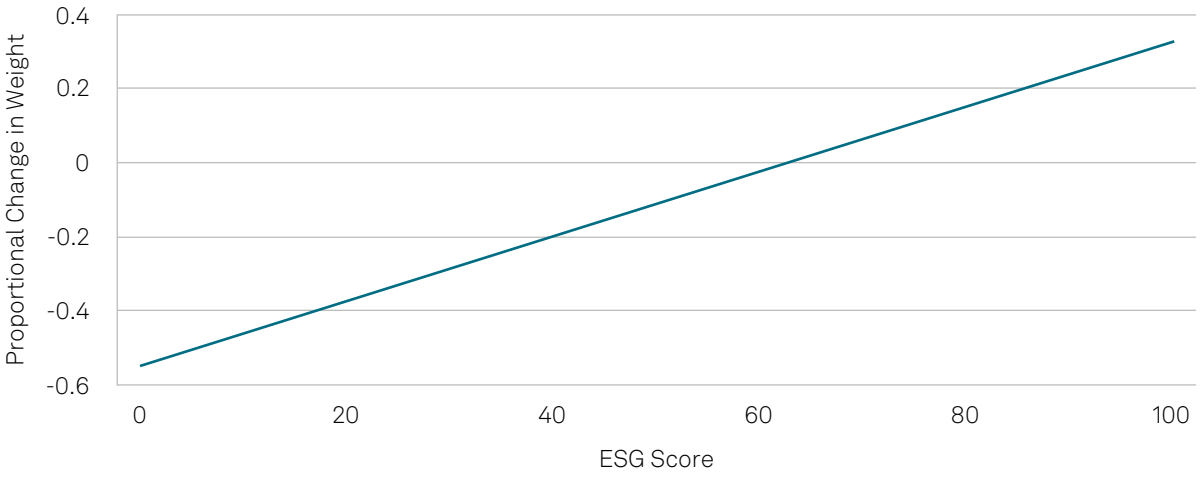
$$\text{minimize} \sum_{i=1}^{N} \left(\frac{(w_i^* - w_i)^2}{w_i} \right)$$

where, w_i^* and w_i are the optimized and underlying benchmark index weights of constituent i, respectively.

In practice, when combined with a single constraint to improve an index-level sustainability metric (e.g., ESG scores) to a predefined target, we observe that the relationship between the proportional changes in each company's weight and the sustainability metric is perfectly correlated. In other words, only the sustainability data is driving the constituent weight changes — and so they are completely explainable.

[1] Active share represents half of the sum of absolute weight differences across constituents in an index compared to its underlying index. In practice, this would be the total index weight that would need to be replaced in the underlying index to replicate the new index. Therefore, active share typically indicates how "active" an index is compared to a float-adjusted market-capitalization index.

Exhibit 1: Relationship between Proportional Change in Weights with ESG Scores — Simple Glass-Box Index



The simple glass-box index is hypothetical.

Source: S&P Dow Jones Indices LLC. Data as of May 2022 rebalance. Based on S&P Global LargeMidCap and subject to constraint on 10% ESG score improvement. The proportional change in weight is defined as the constrained weight minus the unconstrained weight, divided by the unconstrained weight. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

2. Why do proportional weight changes matter?

S&P DJI's glass-box optimization process ensures weight changes are related to the company's underlying benchmark weight. For instance, two equally sustainable constituents — one large, one small — will be fairly rewarded within the simple glass-box-optimized index highlighted above. For example, both may increase proportionally by 1.2 times, rather than both receiving an additional two percentage points in index weight absolutely. The added benefit is that since the final index baskets are anchored to the weights of the float-adjusted market-capitalization-weighted benchmark, they may naturally inherit much of its enhanced liquidity and lower turnover.

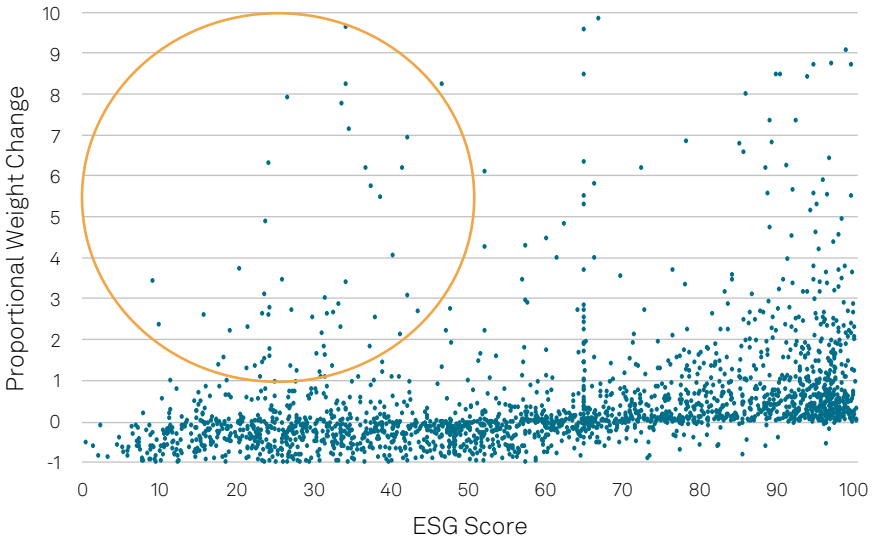
3. What are the pitfalls when not using the glass-box approach (i.e., a "black box")?

Complex and opaque. Glass-box optimization has been designed as an alternative to traditional risk model-based optimization. Such approaches focus on minimizing tracking error to an underlying index by matching the exposure to various sources of systematic risk (e.g., quality, value, momentum, etc.). However, risk model-based optimizers may often be described as black boxes since the weights determined by these models are not easily explainable. The final weights can be a complex function of many risk factors — most, if not all, of which are typically not sustainability related.

Unsuited to sustainability. Furthermore, risk model-based optimizations typically achieve their objectives by making weight changes in absolute terms. For instance, two equally preferable constituents — one large, one small — may receive the same index weight increase in percentage points. Under a sustainability lens, this may represent an arguably unfair redistribution of index weights given the smaller constituent would receive a larger increase in proportional terms. As a consequence, risk model-based optimizations are likely to need more constraints in place to control for liquidity and turnover.

Rewarding the wrong constituents. Most importantly, when analyzing the weight changes in proportional terms, some changes may even appear to directly conflict with the company's sustainability data points — all of which may be masked by the targeted objectives still being achieved at the index level.

Exhibit 2: Relationship between Proportional Weight Change with ESG Scores — Risk Model-Optimized Index



Low-scoring constituents receiving large weight increases in risk model-based optimization.

The risk model-optimized index is hypothetical.

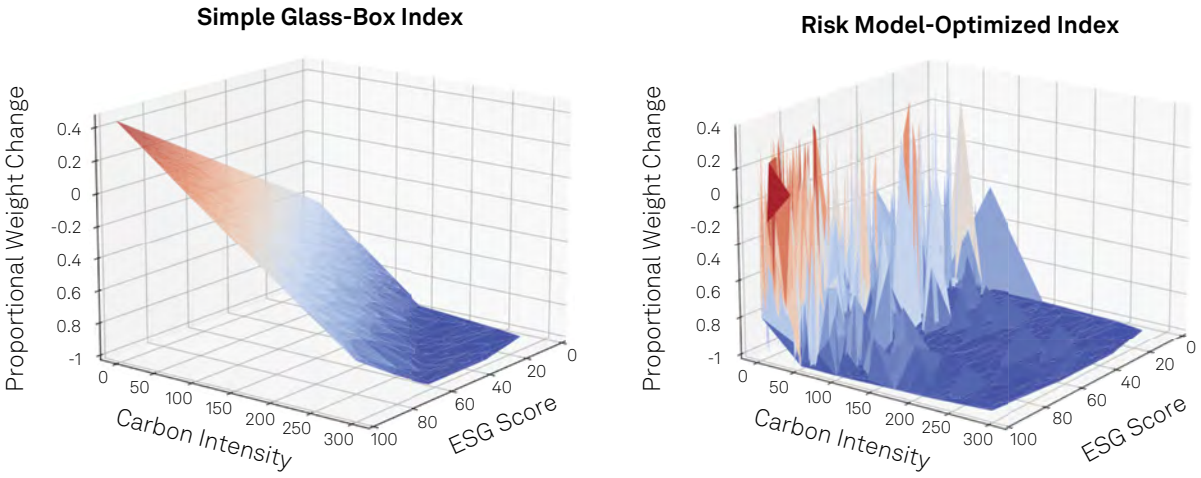
Source: S&P Dow Jones Indices LLC. Data as of May 2022 rebalance. The proportional change in weight is defined as the constrained weight minus the unconstrained weight, divided by the unconstrained weight. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

4. Can multiple sustainability-related index targets be applied at the same time?

Constrained index optimization is ideally suited to the often multi-faceted nature of sustainability-related objectives. It allows multiple, and often weakly correlated, datasets to be targeted for improvement and achieved simultaneously (e.g., ESG scores and carbon intensity). Like with a single constraint, glass-box optimization continues to deliver more transparent solutions compared to an equivalent risk model-based approach. Importantly, the proportional changes in index weights continue to be explainable by, and well correlated to, the underlying sustainability datasets.

When applying both an ESG score improvement constraint and carbon intensity reduction to a simple glass-box optimized index, we observe a strong relationship between the proportional changes in index weights and the two datasets. The same is not true for the risk model approach.

Exhibit 3: Relationship between the Proportional Weight Changes, ESG Scores, and Carbon Intensities for the Simple Glass-Box and Risk Model-Optimized Indices



All indices are hypothetical.

Source: S&P Dow Jones Indices LLC. Data as of May 2022 rebalance. Note: the set of observations is limited to include only those assets with a carbon intensity less than 300, and for the risk model-optimized index, proportional weight change less than 5 to aid visual interpretation. Charts are provided for illustrative purposes and reflect hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

5. Can glass-box optimization control active sector and country exposure?

The simple glass-box objective function can be expanded to include additional penalties to help limit the active exposure to various other groups of constituents, such as sectors and countries.

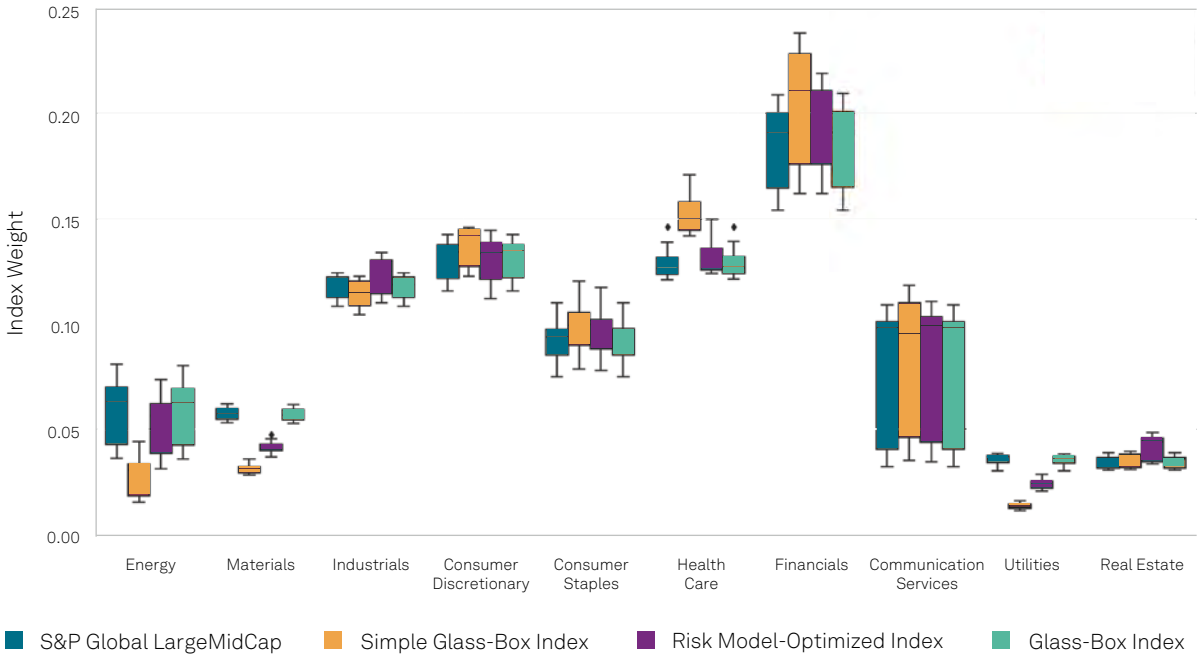
$$\text{minimize}\left\{\frac{1}{N}\sum_{i=1}^{N}\left(\frac{(w_i^* - w_i)^2}{w_i}\right) + \frac{1}{M}\sum_{i=1}^{N}\left(\frac{(w_j^s - w_j^{s*})^2}{w_j^s}\right) + \frac{1}{K}\sum_{k=1}^{K}\left(\frac{(w_k^c - w_k^{c*})^2}{w_k^c}\right)\right\}$$

Stock Penalty **Sector Penalty** **Country Penalty**

where w_j^s and w_j^{s*} indicate the weight in sector j for the benchmark index and the optimized index, respectively. Similarly, w_k^c and w_k^{c*} are the weights of country k in the benchmark index and in the optimized index, respectively. Note, dividing each component in the objective by the number of terms in the summation ensures the contribution
of each term is invariant to the number of groups. Further group penalties may be added, such as one for industry weight deviations.

Minimal sector and country deviations are found. The expanded objective function looks to find the solution with minimal penalties (i.e., deviations from the underlying benchmark) considering and balancing all three groups (i.e., stocks, sectors and countries). Therefore, as shown in Exhibit 4 for sectors, compared to the simple glass-box optimization approach, group deviations are minimized. Moreover, this is done without specifying hard boundaries that may otherwise create infeasible or concentrated solutions.

Exhibit 4: Distribution of Sector Weights Relative to the Underlying Benchmark

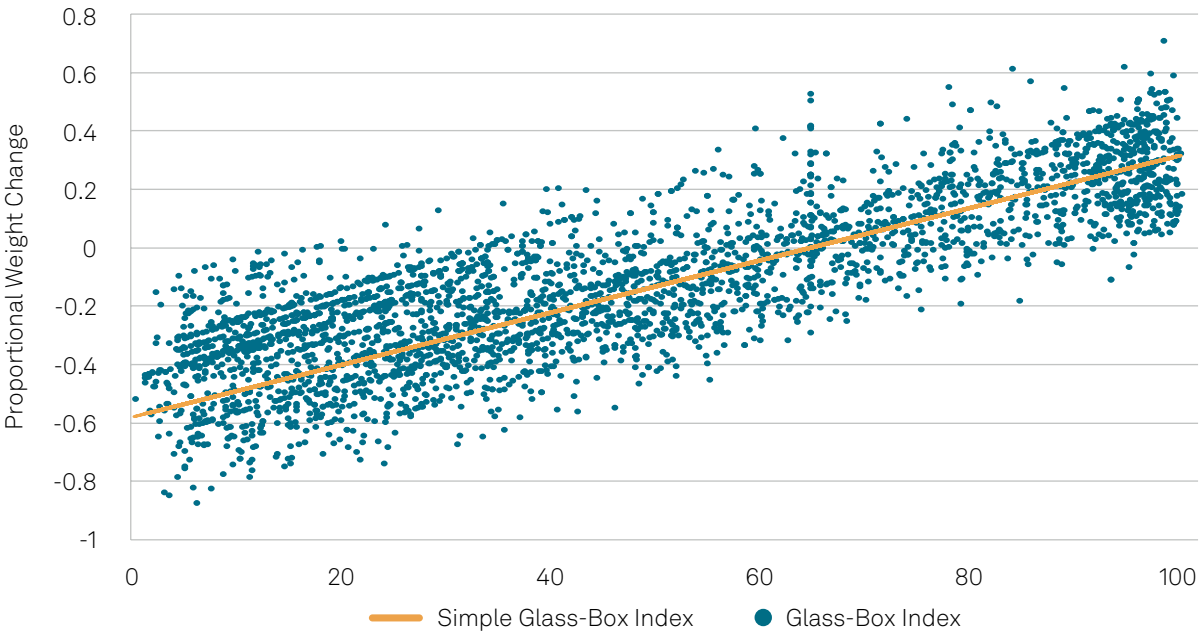


All indices are hypothetical.

Source: S&P Dow Jones Indices LLC. Data as of May 2022 rebalance. Indices are based on the S&P Global LargeMidCap and subject to constraints on both 10% ESG score improvement and 75% carbon intensity reduction. The distributions are constructed using data as of each rebalancing date. Chart is provided for illustrative purposes.

Transparency within each peer group remains. The inclusion of these group penalties in the objective function introduces a competition for weight changes across constituents within the same sector-country peer group. Therefore, each constituent should receive proportional weight changes in relation to their peer group's comparative sustainability characteristics. This can be observed in the linear relationships evident for each of the numerous groups below.

Exhibit 5: Relationship between the Proportional Weight Change and ESG Score for the Simple Glass-Box Index and Glass-Box Index with Group Penalty



All indices are hypothetical.

Source: S&P Dow Jones Indices LLC. Data as of May 2022 rebalance. Based on the S&P Global LargeMidCap and subject to constraint on 10% ESG score improvement. Chart is provided for illustrative purposes.

6. How well does glass-box optimization control tracking error?

For diversified indices, active share and tracking error are closely related quantities, such that minimizing one is likely to come close to minimizing the other. And so, even with the simple glass-box approach, we observe reasonably low levels of tracking error in pursuit of meeting the sustainability objectives of the index in a transparent manner.

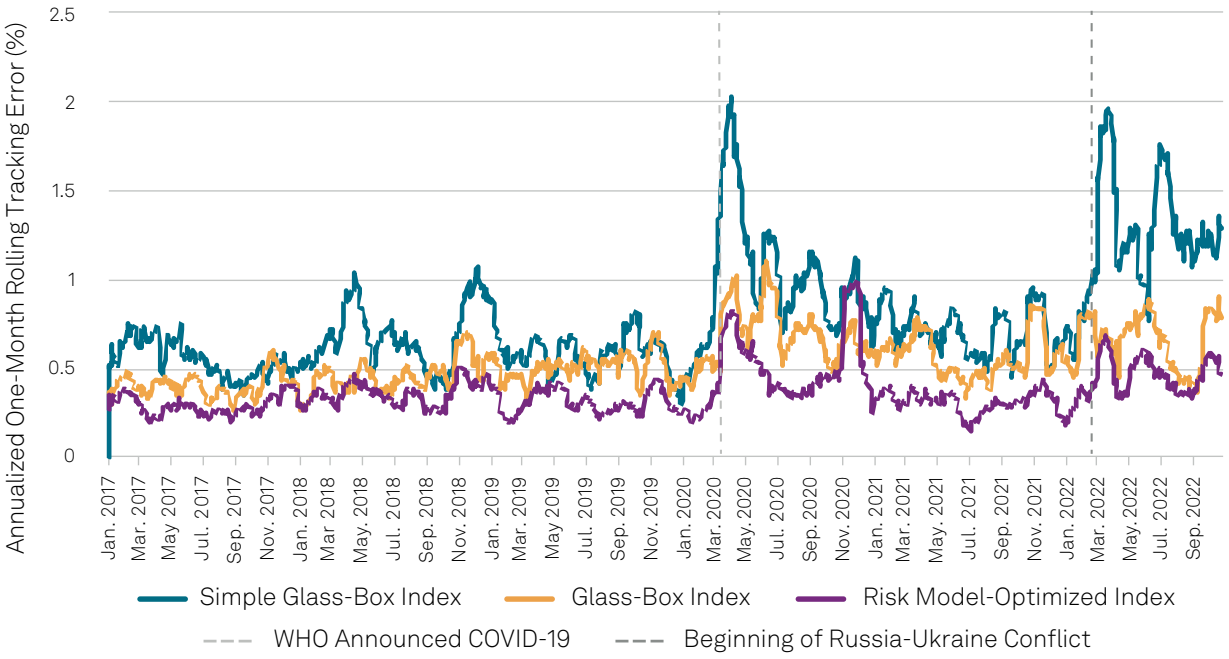
In comparison, historical back-tests reveal that the risk model-optimized indices have achieved lower tracking error than those derived using the simple glass-box optimization, indicating that at least some of the additional factors included in the risk model are important for explaining returns.

However, our analysis shows that the tracking error was significantly reduced by including country and sector group penalties in the glass-box objective function. This reduces the magnitude of active country and sector bets, and the resultant index more closely approaches the lower tracking error delivered by the risk model-optimized index.

In conclusion, for a relatively small sacrifice in tracking error, glass-box optimization can deliver transparent and diversified solutions suited to meet the needs of the multi-faceted nature of sustainability indices.

Exhibit 6: Tracking Error Statistics for the Simple Glass-Box, Risk Model-Optimized, and Glass-Box Indices with ESG and Carbon Constraints

Period	Annualized Tracking Error (%)		
	Simple Glass-Box Index	Risk Model-Optimized Index	Glass-Box Index
One-Year	1.21	0.44	0.66
Three-Year	1.01	0.44	0.65
Five-Year	0.88	0.40	0.59
Since Nov. 30, 2016	0.84	0.39	0.56



All indices are hypothetical.

Source: S&P Dow Jones Indices LLC. Data from Nov. 30, 2016, to Oct. 31, 2022. Past performance is no guarantee of future results. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

7. Where can I see glass-box optimization in action?

S&P DJI's glass-box optimization underpins a wide range of S&P DJI indices, including:

- S&P PACT Indices (S&P Paris-Aligned & Climate Transition Indices)
  - See our Index Education piece, Exploring S&P PACT™ Indices Weight Attribution for a full overview of our commitment to weighting transparency in these indices.
- S&P Carbon Budget Indices
- S&P Sustainability Enhanced Indices
- S&P ESG Enhanced Sector Indices
- S&P GSCI Climate Aware and S&P GSCI Light Energy Climate Aware Indices

S&P DJI's ability to deliver transparent index-based solutions is unmatched due to the increased sophistication of our index construction capabilities and our unrivalled access to pioneering environmental and sustainability datasets from S&P Global Sustainable1. Find out more about S&P Global Sustainable1's data offering here.

8. Where can I learn even more about S&P DJI's glass-box optimization?

Our comprehensive research paper, Glass-Box Optimization: Bringing Clarity to Sustainability Indices, takes a deeper analytical dive into the relative merits and outcomes of our glass-box approach.

Performance Disclosure/Back-Tested Data

All information presented prior to an index's Launch Date is hypothetical (back-tested), not actual performance. The back-test calculations are based on the same methodology that was in effect on the index Launch Date. However, when creating back-tested history for periods of market anomalies or other periods that do not reflect the general current market environment, index methodology rules may be relaxed to capture a large enough universe of securities to simulate the target market the index is designed to measure or strategy the index is designed to capture. For example, market capitalization and liquidity thresholds may be reduced. Complete index methodology details are available at www.spglobal.com/spdji. Past performance of the Index is not an indication of future results. Back-tested performance reflects application of an index methodology and selection of index constituents with the benefit of hindsight and knowledge of factors that may have positively affected its performance, cannot account for all financial risk that may affect results and may be considered to reflect survivor/look ahead bias. Actual returns may differ significantly from, and be lower than, back-tested returns. Past performance is not an indication or guarantee of future results. Please refer to the methodology for the Index for more details about the index, including the manner in which it is rebalanced, the timing of such rebalancing, criteria for additions and deletions, as well as all index calculations. Back-tested performance is for use with institutions only; not for use with retail investors.

S&P Dow Jones Indices defines various dates to assist our clients in providing transparency. The First Value Date is the first day for which there is a calculated value (either live or back-tested) for a given index. The Base Date is the date at which the index is set to a fixed value for calculation purposes. The Launch Date designates the date when the values of an index are first considered live: index values provided for any date or time period prior to the index's Launch Date are considered back-tested. S&P Dow Jones Indices defines the Launch Date as the date by which the values of an index are known to have been released to the public, for example via the company's public website or its data feed to external parties. For Dow Jones-branded indices introduced prior to May 31, 2013, the Launch Date (which prior to May 31, 2013, was termed "Date of introduction") is set at a date upon which no further changes were permitted to be made to the index methodology, but that may have been prior to the Index's public release date.

Typically, when S&P DJI creates back-tested index data, S&P DJI uses actual historical constituent-level data (e.g., historical price, market capitalization, and corporate action data) in its calculations. As ESG investing is still in early stages of development, certain datapoints used to calculate S&P DJI's ESG indices may not be available for the entire desired period of back-tested history. The same data availability issue could be true for other indices as well. In cases when actual data is not available for all relevant historical periods, S&P DJI may employ a process of using "Backward Data Assumption" (or pulling back) of ESG data for the calculation of back-tested historical performance. "Backward Data Assumption" is a process that applies the earliest actual live data point available for an index constituent company to all prior historical instances in the index performance. For example, Backward Data Assumption inherently assumes that companies currently not involved in a specific business activity (also known as "product involvement") were never involved historically and similarly also assumes that companies currently involved in a specific business activity were involved historically too. The Backward Data Assumption allows the hypothetical back-test to be extended over more historical years than would be feasible using only actual data. For more information on "Backward Data Assumption" please refer to the FAQ. The methodology and factsheets of any index that employs backward assumption in the back-tested history will explicitly state so. The methodology will include an Appendix with a table setting forth the specific data points and relevant time period for which backward projected data was used.

Index returns shown do not represent the results of actual trading of investable assets/securities. S&P Dow Jones Indices maintains the index and calculates the index levels and performance shown or discussed but does not manage actual assets. Index returns do not reflect payment of any sales charges or fees an investor may pay to purchase the securities underlying the Index or investment funds that are intended to track the performance of the Index. The imposition of these fees and charges would cause actual and back-tested performance of the securities/fund to be lower than the Index performance shown. As a simple example, if an index returned 10% on a US $100,000 investment for a 12-month period (or US $10,000) and an actual asset-based fee of 1.5% was imposed at the end of the period on the investment plus accrued interest (or US $1,650), the net return would be 8.35% (or US $8,350) for the year. Over a three-year period, an annual 1.5% fee taken at year end with an assumed 10% return per year would result in a cumulative gross return of 33.10%, a total fee of US $5,375, and a cumulative net return of 27.2% (or US $27,200).

General Disclaimer

ESG Indices Disclaimer

S&P DJI provides indices that seek to select, exclude, and/or weight index constituents based on, but not limited to, certain environmental, social or governance (ESG) indicators, or a combination of those indicators, including the following: environmental indicators (including the efficient use of natural resources, the production of waste, greenhouse gas emissions, or impact on biodiversity); social indicators (such as, inequality and investment in human capital); governance indictors (such as sound management structures, employee relations, remuneration of staff, tax compliance, respect for human rights, anti-corruption and anti-bribery matters), specific sustainability or values-related company involvement indicators (for example, production/distribution of controversial weapons, tobacco products, or thermal coal), or controversies monitoring (including research of media outlets to identify companies involved in ESG-related incidents).

S&P DJI ESG indices use ESG metrics and scores in the selection and/or weighting of index constituents. ESG scores or ratings seek to measure or evaluate a company's, or an asset's, performance with respect to environmental, social and corporate governance issues.

The ESG scores, ratings, and other data used in S&P DJI ESG indices is supplied directly or indirectly by third parties (note these parties can be independent affiliates of S&P Global or unaffiliated entities) so an S&P DJI ESG index's ability to reflect ESG factors depends on these third parties' data accuracy and availability.

ESG scores, ratings, and other data may be reported (meaning that the data is provided as disclosed by companies, or an asset, or as made publicly available), modelled (meaning that the data is derived using a proprietary modelling process with only proxies used in the creation of the data), or reported and modelled (meaning that the data is either a mix of reported and modelled data or is derived from the vendor using reported data /information in a proprietary scoring or determination process).

ESG scores, ratings, and other data, whether from an external and/or internal source, is based on a qualitative and judgmental assessment, especially in the absence of well-defined market standards, and due to the existence of multiple approaches and methodologies to assess ESG factors and considerations. An element of subjectivity and discretion is therefore inherent in any ESG score, rating, or other data and different ESG scoring, rating, and/or data sources may use different ESG assessment or estimation methodologies. Different persons (including ESG data ratings, or scoring providers, index administrators or users) may arrive at different conclusions regarding the sustainability or impact of a particular company, asset, or index.

Where an index uses ESG scores, ratings or other data supplied directly or indirectly by third parties, S&P DJI does not accept responsibility for the accuracy of completeness of such ESG scores, ratings, or data. No single clear, definitive test or framework (legal, regulatory, or otherwise) exists to determine 'ESG', 'sustainable', 'good governance', 'no adverse environmental, social and/or other impacts', or other equivalently labelled objectives. In the absence of well-defined market standards and due to the existence of multitude approaches, the exercise of judgment is necessary. Accordingly, different persons may classify the same investment, product and/or strategy differently regarding 'ESG', 'sustainable', 'good governance', 'no adverse environmental, social and/or other impacts', or other equivalently labelled objectives. Furthermore, the legal and/or market position on what constitutes an 'ESG', 'sustainable', 'good governance', 'no adverse environmental, social and/or other impacts', or other equivalently labelled objectives may change over time, especially as further regulatory or industry rules and guidance are issued and the ESG sustainable finance framework becomes more sophisticated.

Prospective users of an S&P DJI ESG Index are encouraged to read the relevant index methodology and related disclosures carefully to determine whether the index is suitable for their potential use case or investment objective.