S&P Dow Jones Indices

A Division of S&P Global

Exploring S&P PACT™ Indices Weight Attribution

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Executive Summary

This paper provides transparency around the S&P PACT Indices (S&P Paris-Aligned & Climate Transition Indices),[1, 2] a sophisticated index solution to align with a 1.5°C trajectory[3] (EU PAB and CTB Aligned). The indices mitigate a multifaceted range of potential financial risks, while providing exposure to opportunities companies may face from climate change, as laid out by the Task Force on Climate-related Financial Disclosures (TCFD).[4] This paper examines four core universes, including the S&P 500®, S&P Eurozone LargeMidCap, S&P Developed LargeMidCap and S&P Japan LargeMidCap.

– The S&P PACT Index weights, relative to the benchmark index, are attributable to an exclusion effect (whether a stock is eligible for the index) or reweighting effect (how a stock performs from a climate perspective), as seen in Exhibit 1.

– The exclusion effect accounts for around 20% of active weights for the S&P Climate Transition (CT) Indices across most universes, while for the more ambitious S&P Paris-Aligned Climate (PA) Indices, exclusions account for 35%-65% of deviations from benchmark weights. The reweighting effect explains the remaining active share.

– The reweighting effect is driven by climate and index construction factors, which are affected by the strength of constraint, climate datasets distributions and climate factor correlations.

[1] Transition to a 1.5°C World with the S&P Paris-Aligned & Climate Transition Indices (2020)

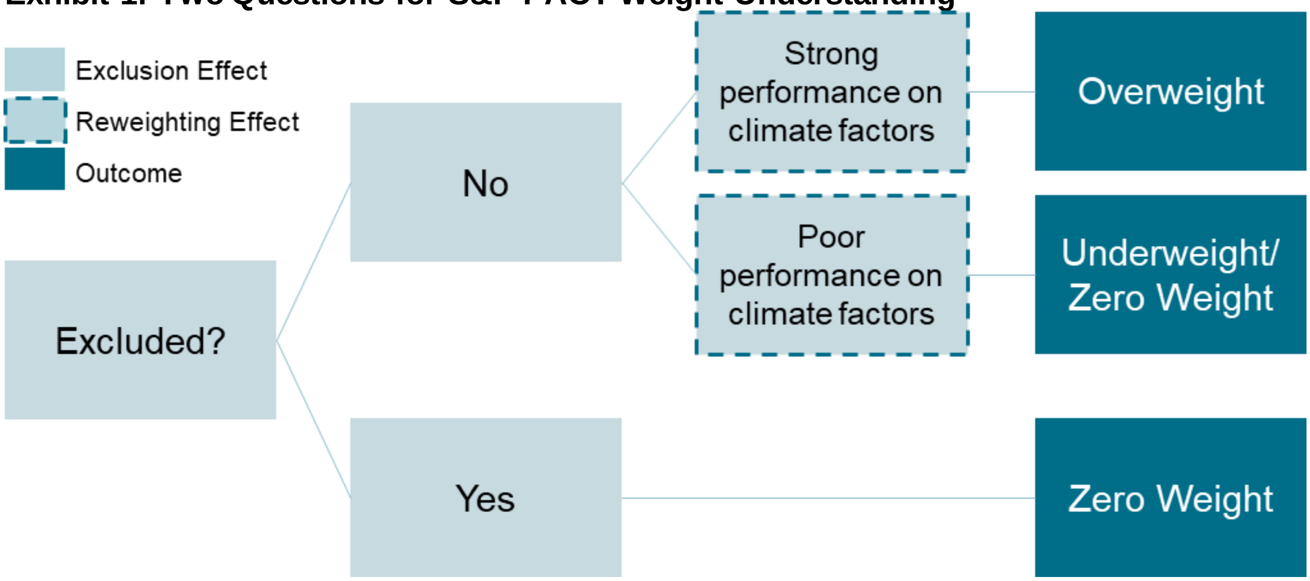
[2] S&P Paris-Aligned & Climate Transition (PACT) Indices Methodology

[3] Using the 1.5°C scenario with no or limited overshoot, as recommended by the TEG (2019) and IPCC (2018)

[4] TCFD Final Report (2017)

- A company's transition pathway, sustainability performance score (as measured by the S&P DJI ESG Score), physical risk exposure, carbon intensity and high climate impact revenues are all key drivers of weighting S&P PACT Index constituents.
- Climate considerations can be appraised through different lenses, and so we use a range of different datapoints within S&P PACT Indices to capture climate in a holistic way. The high quality climate factors show low correlations between each other, hence explicitly controlling for each of them within the PACT Indices ensures a holistic approach to climate risks and opportunities.
- Eligible companies can be allocated a higher weight in the S&P PACT Indices by significantly reducing their carbon intensity year-on-year, disclosing more information regarding sustainability policies and metrics, improving performance against sustainability metrics, divesting assets in locations highly exposed to physical risks, and reducing assets' physical risk sensitivity factors.

Exhibit 1: Two Questions for S&P PACT Weight Understanding



Source: S&P Dow Jones Indices LLC. Chart is provided for illustrative purposes.

Introduction

The S&P PACT Indices aim to go beyond the Paris Agreement's minimum goal by aligning with a 1.5°C trajectory[5] while maintaining broad, diversified exposure. The S&P PACT Indices also incorporate the minimum standards of the EU's Low Carbon Benchmark requirements[6]

[5] Using the 1.5°C scenario with no or limited overshoot, as recommended by the TEG (2019) and IPCC (2018)

[6] Regulation (EU) 2019/2089 of the European Parliament and of the Council amending Regulation (EU) 2016/1011

and the TCFD's recommendations. These objectives are possible due to innovative forward-looking data from S&P Global Trucost, informing both transition and physical risks.

The EU Low Carbon Benchmark Regulation outlines minimum standards for two climate benchmarks: the Climate Transition Benchmark (CTB) and the more ambitious Paris-Aligned Benchmark (PAB).[7] The S&P PACT Indices are two methodologies—the S&P Climate Transition (CT) Index Series and the S&P Paris-Aligned Climate (PA) Index Series, which both aim to incorporate the respective regulatory standards.

The S&P PACT Indices offer a multifaceted solution to holistically mitigate potential climate risk and assess opportunities, as laid out by the TCFD. With many competing climate objectives, the S&P PACT Indices are a sophisticated solution and this paper provides further transparency on what factors are driving constituent weights relative to the parent index.

To supplement the forward-looking and evidence-based datasets from S&P Global Trucost, the S&P PACT Indices use data to understand product involvement (provided by S&P Global Trucost and Sustainalytics), United Nations Global Compact (UNGC) screening (from Sustainalytics), and ESG score data (from S&P Global Sustainable1).

Two Questions to Consider

Stocks within the S&P PACT Indices largely receive their weighting for one of two reasons.

- The Exclusion Effect: Is a stock eligible for the index?
- The Reweighting Effect: How does a stock perform from a climate perspective?

Companies with exposure to controversial weapons, tobacco, public controversies and UNGC violations are excluded from the S&P PACT Indices.[8] The S&P PA Indices go further by excluding index constituents based on fossil fuel exposure at specific thresholds (as mandated by the regulation), as well as removing companies involved in small arms, military contracting, gambling and alcohol. Companies that do not meet the minimum eligibility standards have a weight of zero in the S&P PACT Indices, as shown in Exhibit 1.

Companies passing this exclusion-based hurdle are reweighted to minimize possible modifications to the benchmark, while meeting climate and index construction criteria. The optimization's objective function penalizes changes in a stock's weight the further it travels from its weight in the underlying index, explicitly seeking country, sector and stock weight neutrality (see Equation 1).

[7] TEG Final Report (2019)

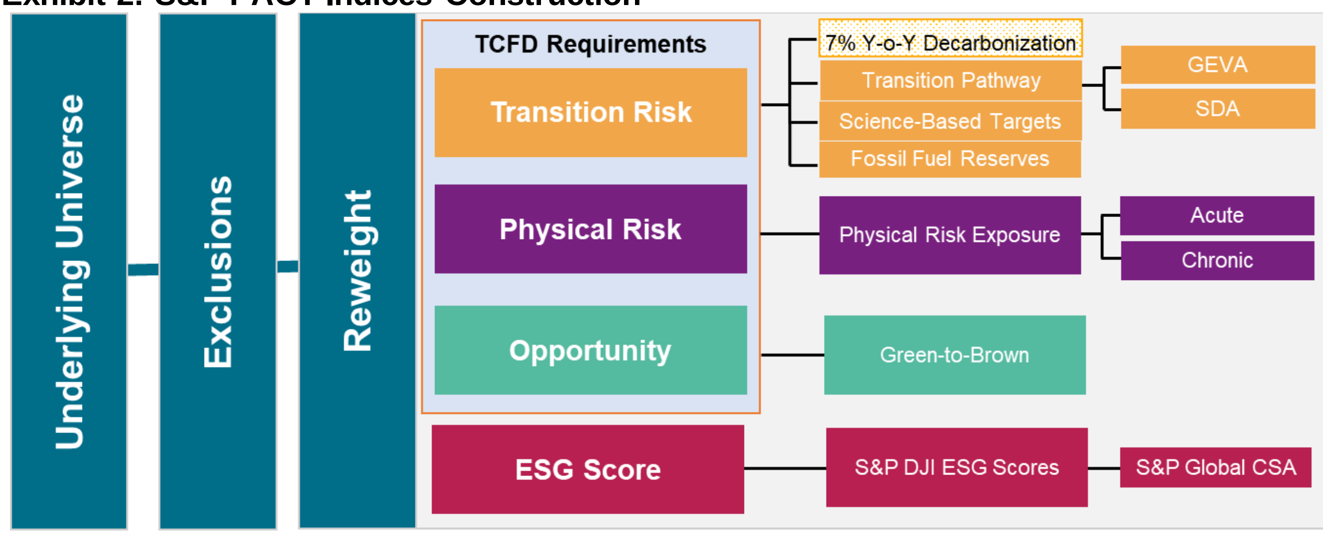
[8] The S&P PACT Indices were designed using the TEGs recommendations.

Equation 1: S&P PACT Index Objective Function

$$Minimize\ \left(\frac{1}{n}\sum\left[\frac{(PACT\ Weight_i - Benchmark\ Weight_i)^2}{Benchmark\ Weight_i}\right] + \frac{1}{k}\sum\left[\frac{(PACT\ Sector\ Weight_i - Benchmark\ Sector\ Weight_i)^2}{Benchmark\ Sector\ Weight_i}\right] + \frac{1}{m}\sum\left[\frac{(PACT\ Country\ Weight_i - Benchmark\ Country\ Weight_i)^2}{Benchmark\ Country\ Weight_i}\right]\right)$$

Climate criteria and exclusions are largely driven by the EU Low Carbon Benchmark requirements and the TCFD recommendations on climate-related financial risks and opportunities. Index construction constraints to maintain diversification, liquidity and tradability of the index are included. Climate factor-based constraints and how they are used within the S&P PACT Indices are portrayed in Exhibit 2 and a full list of constraints is included in Appendix C.

Exhibit 2: S&P PACT Indices Construction



Source: S&P Dow Jones Indices LLC. Chart is provided for illustrative purposes.

Ultimately, stock weights are determined by whether the company is eligible for the index, and if so, how it performs from a climate perspective.

Weight Changes from Exclusions and Reweighting

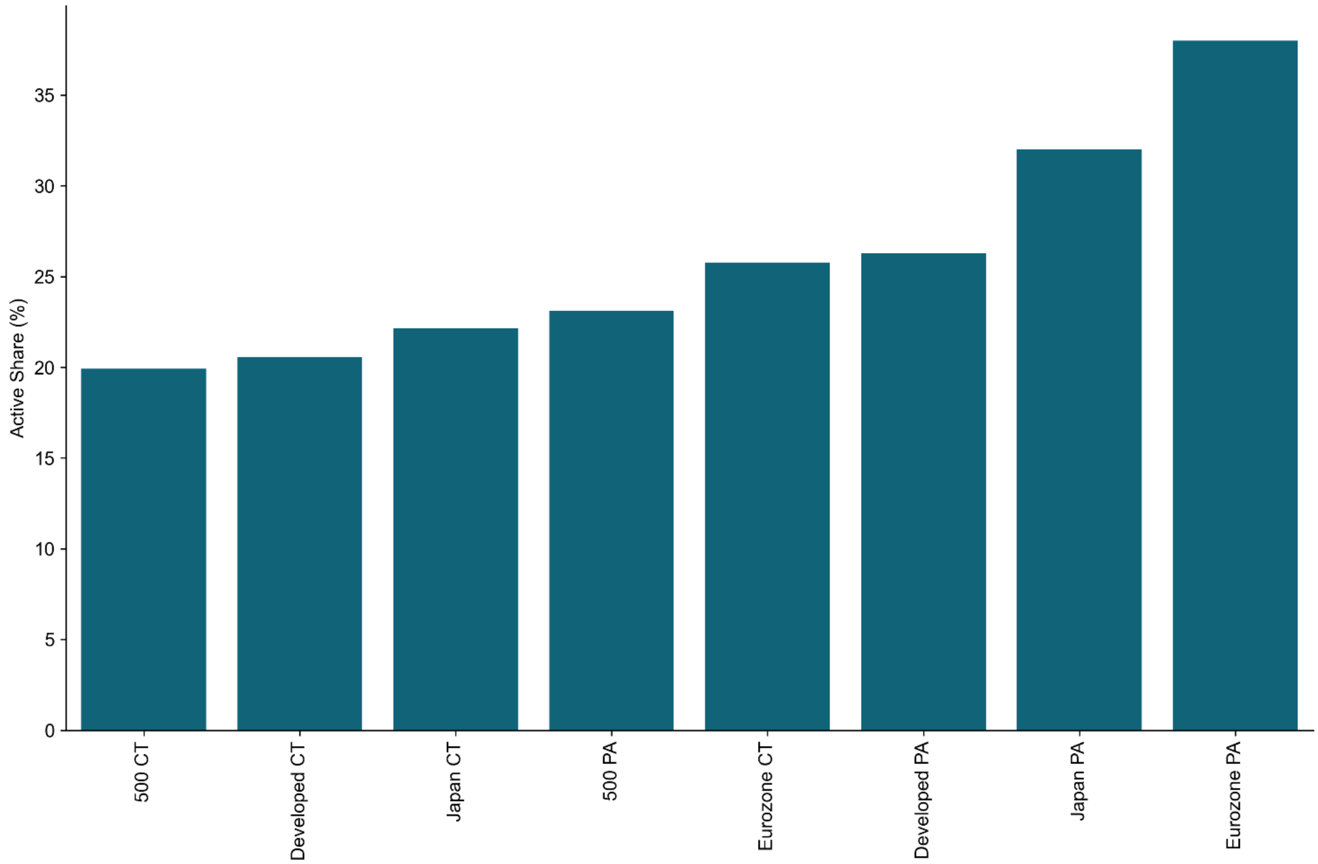
Index active share is an active risk measure between benchmarks and subindices, where active share represents the benchmark index percentage that would be sold to meet the subindex weights. Active share for an S&P PACT Index is calculated as the sum of the absolute weight difference between the benchmark and subindex, for stock i, divided by two (see Equation 2). This largely resembles the S&P PACT Index objective function, which primarily seeks active share minimization.

Equation 2: Active Share

$$Active\ Share = \sum \frac{|Benchmark\ Weight_i - PACT\ Weight_i|}{2}$$

To understand the relative impact of exclusions and reweighting on S&P PACT Index weights, active share from each is considered. Exhibit 3 shows the total active share of the S&P PACT Indices. Unsurprisingly, due to extra exclusions and more ambitious climate constraints, the S&P PA Indices have greater active share than their CT counterparts.[9]

Exhibit 3: S&P PACT Indices Total Active Share



Source: S&P Dow Jones Indices LLC. Data as of June 30, 2023. Chart is provided for illustrative purposes.

We define the exclusion effect as the sum of the weights of excluded constituents in the benchmark (equivalent to the active share of the excluded constituents) and define the reweighting effect as the S&P PACT Index active share minus the exclusion effect. An interaction effect between exclusions and climate factors will likely occur. Therefore, the

[9] The indices used in our analysis and (their respective abbreviations) are as follows: S&P 500 Net Zero 2050 Climate Transition ESG Index (500 CT), S&P Eurozone LargeMidCap Net Zero 2050 Climate Transition ESG Index (Eurozone CT), S&P Japan LargeMidCap Net Zero 2050 Climate Transition ESG Index (Japan CT), S&P Developed Ex-Korea LargeMidCap Net Zero 2050 Climate Transition ESG Index (Developed CT), S&P 500 Net Zero 2050 Paris-Aligned ESG Index (500 PA), S&P Japan LargeMidCap Net Zero 2050 Paris-Aligned ESG Index (Japan PA), S&P Eurozone LargeMidCap Net Zero 2050 Paris-Aligned ESG Index (Eurozone PA), and S&P Developed Ex-Korea LargeMidCap Net Zero 2050 Paris-Aligned ESG Index (Developed PA).

reweighting effect can be attributed to climate and index construction factors, along with the interaction between these factors and exclusions.

Equation 3: The Exclusion Effect

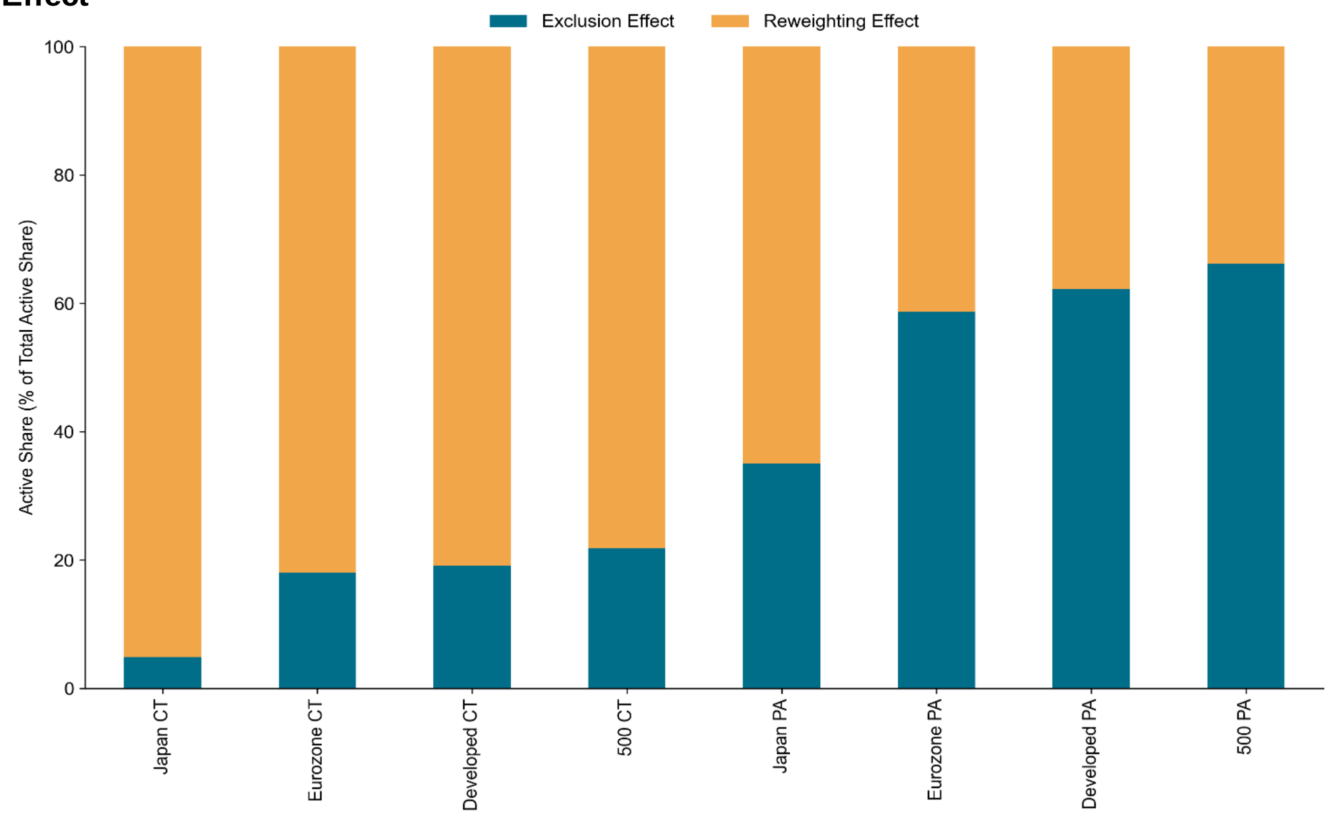
$$\boldsymbol{Exclusion}\ Effect = Weight\ of\ Excluded\ Constituents$$

Equation 4: The Reweighting Effect

$$Reweighting\ Effect = \ PACT\ Index\ Active\ Share - \ Exclusion\ Effect$$

As the index active share and the weight of excluded companies are known, the reweighting effect can be calculated (see Equation 4). Exhibit 4 shows the active share percentage that comes from exclusions and reweighting. This method has vague similarities to Brinson performance attribution.[10]

Exhibit 4: S&P PACT Indices Active Share from the Exclusion Effect and Reweighting Effect



Source: S&P Dow Jones Indices LLC. Data as of June 30, 2023. Chart is provided for illustrative purposes.

The S&P PA Indices are observed to have a greater percentage of their active share coming from exclusions, about 50%-70%, than the S&P CT Indices, which see around 20%. While there are more ambitious constraints on the S&P PA Indices, such as an increased carbon

[10] Determinants of Portfolio Performance (1986)

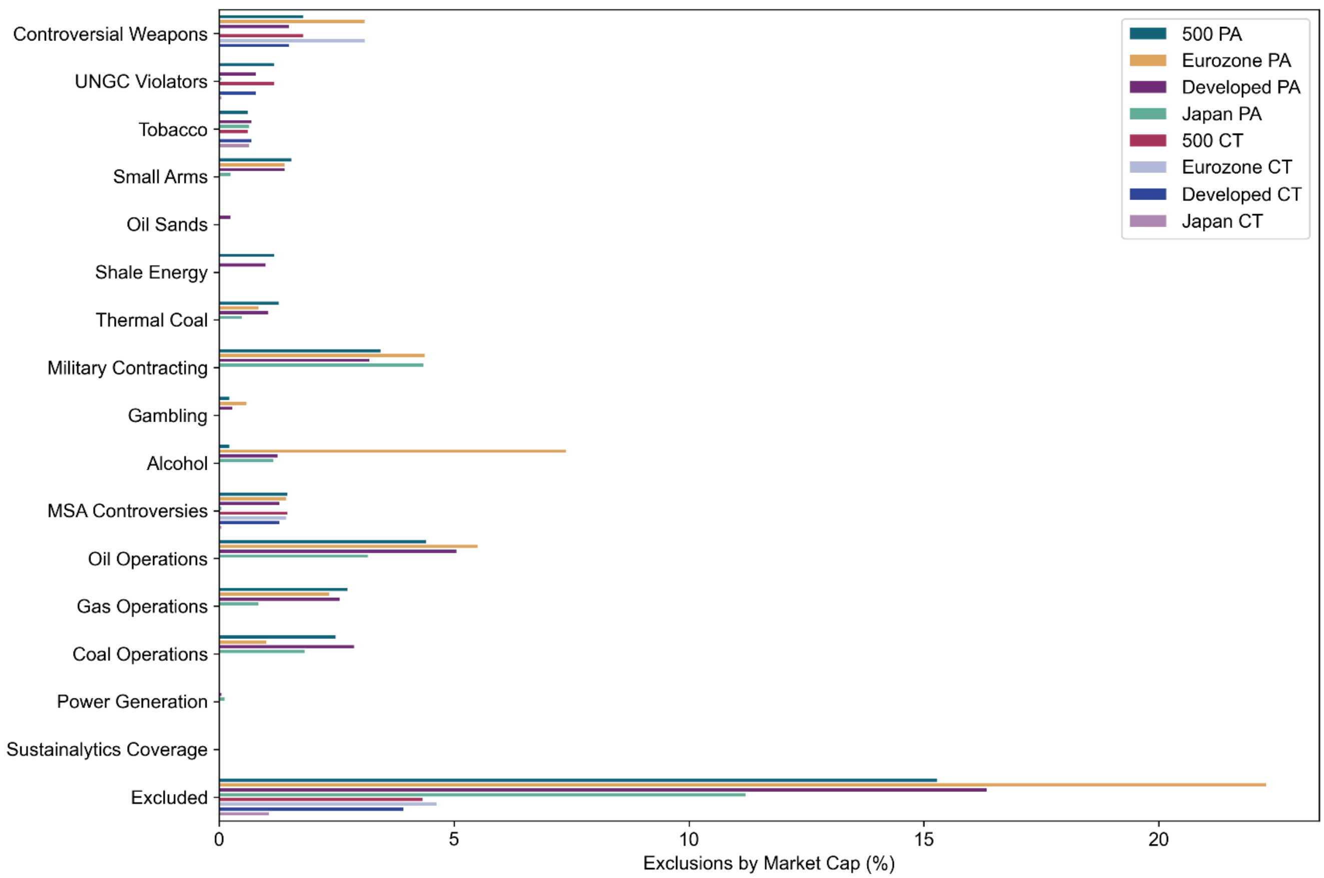
intensity reduction and physical risk constraints, the added fossil fuel and activity-based exclusions contribute more to the increased active risk relative to the S&P CT Indices.

The Exclusion Effect

Out of the consistent exclusions across S&P PACT Indices, most companies are excluded due to controversial weapons involvement, followed by tobacco and those that violate the UNGC Principles or that have been flagged by S&P Global Media and Stakeholder Analysis (MSA). Companies without product involvement or UNGC research coverage are not eligible for inclusion.

When it comes to exclusions, differences between the S&P CT and PA Indices lay within fossil fuel exclusions and additional activity-based exclusions, as these apply only to the S&P PA Indices. Again, the weight excluded is similar across regions, with oil operations accounting for the highest number of exclusions. Some companies are excluded for multiple reasons, so "Excluded" bars do not represent a sum of all exclusion bars. Total weight excluded is around 5% across CT Indices, while for PA Indices it is between 11% and 23%, with the universe most affected being the eurozone.

Exhibit 5: S&P PACT Indices Exclusions



Source: S&P Dow Jones Indices LLC, S&P Global Trucost and Sustainalytics. Data as of June 30, 2023. Chart is provided for illustrative purposes.

The Reweighting Effect

While understanding the impact exclusions have on the eligible universe, and therefore the index, is simple, understanding the impact of climate-related factors is more nuanced. These climate factors are distributed and scaled differently and have varying degrees of correlation. Addressing each climate factor with a constraint allows more control of the index-level outcome and greater efficiency.

Within the eligible universe, three aspects affect the climate factor impact on constituent weights:

- Strength of constraint;
- Distribution of data being constrained; and
- Correlation of climate factors.

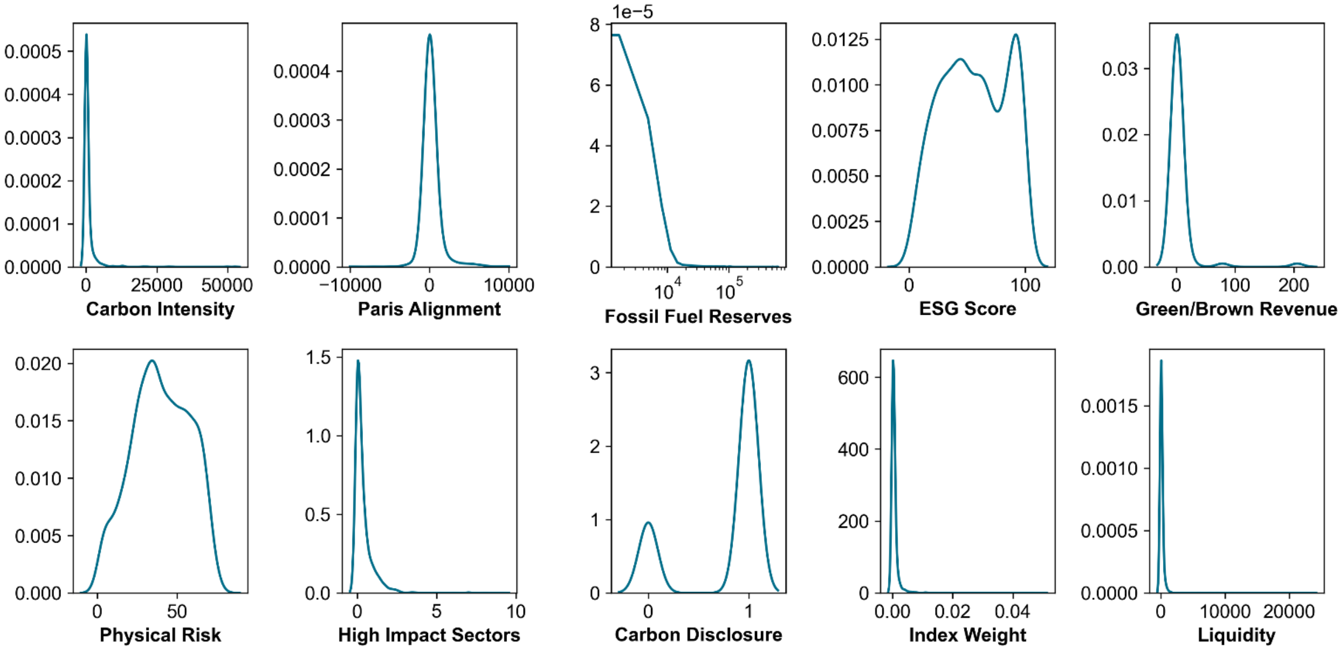
The strength of constraint represents the required difference from the benchmark index. The distribution of datasets will largely determine how much active share must be taken per unit of change toward the required constraint. Correlation of climate factors governs the interaction between climate factors. High correlation allows active share taken to fulfill one climate constraint to also help fulfill others. If not, greater active share is required.

More details on the strength of constraints can be found in the index methodology. We aim to shed light on the relationship between climate and index construction factors, the difference in distributions, and correlations between climate factors. Additionally, we approximate the magnitude of the effect the climate and index construction factors have on S&P PACT Index weights.

Understanding the Climate and Index Construction Factors

Appendix C explains the expected directional relationship between the constituent weight change and climate and index construction factors. It is important to understand the magnitude of weight change required to meet index constraints, data distributions for climate and index construction factors, as well as the strength of constraint. Exhibit 6 shows the data distributions of the underlying climate data used to reweight the S&P PACT Indices. We can observe how different the underlying data distributions are for the various metrics.

Exhibit 6: Climate and Index Construction Factor Data Distributions



Source: S&P Dow Jones Indices LLC, S&P Global Trucost, S&P Global Sustainable1 and FactSet. Data as of June 30, 2023. Charts are provided for illustrative purposes.

The strong positive skew of carbon intensities makes hitting the 30% (CT) or 50% (PA) weighted average carbon intensity (WACI) reduction relatively simple, in terms of active share encountered. Making index weight changes to the most carbon-intensive constituents can have large WACI impacts. As WACI is reduced further, more active share is required per unit of carbon intensity reduction.[11] Similar is true of fossil fuel reserve intensity and green-to-brown share. Far fewer companies have either green or brown revenues or fossil fuel reserves, meaning these likely have a direct impact on fewer stocks. Physical risk has a weaker positive skew, so more active share is required per unit of physical risk mitigation, compared with carbon intensity, green-to-brown share and fossil reserve intensity.

The transition pathway data has a leptokurtic distribution—where the distribution has fatter tails. Appendix A shows the calculation for the index-level transition pathway budget alignment. Due to the leptokurtic distribution, and to take a conservative approach as not to be deemed 1.5°C compatible due to overweighting a small number of outlying stocks, we winsorize the left hand of the distribution. We want this climate factor to overweight companies that appear on the right trajectory to help the index "organically" decarbonize.

The S&P DJI ESG Score is positively skewed, albeit significantly less than other datasets. Carbon disclosure is binary, either 1 (sufficiently disclosed, as researched by S&P Global Trucost) or 0 (insufficiently disclosed).

[11] The S&P Eurozone Paris-Aligned Climate Index Concept Sensitivity Analysis: Decarbonization over Time (2020)

Difference in distributions means optimization has a particularly strong benefit, allowing active share to be placed where it will most efficiently affect index-level characteristics. This is particularly beneficial if the benchmark index does not decarbonize over time, which would require a higher level of relative decarbonization in the future due to the 7% year-on-year decarbonization trajectory.[12]

Adding climate factors beyond carbon intensity will only provide a benefit if these are not perfectly correlated. The lower the correlation, the more benefit additional datasets bring in understanding a company's potential climate risks and opportunities. Expecting backward-looking and forward-looking climate factors to assess transition risk, physical risk and opportunities to have low or negative correlations, while adding further information, seems plausible.

This logic is similar to that of diversification. Modern Portfolio Theory (MPT) teaches us non-perfectly correlated assets underpin the benefit of portfolio diversification. S&P DJI analysis indicates the benefits of diversification across individual stocks,[13] asset classes,[14] factors[15] and sectors.[16]

A climate risk premium associated with theoretical transition risk, physical risk or climate opportunities is yet to be determined, so understanding the diversification of climate factors as improving an alpha signal requires further research. While MPT focuses on risk and return, diversifying high quality climate factors with low or negative correlations to add greater insight seems credible.

In fact, if the goal is to understand potential physical risks, transition risks and opportunities, there is increasing benefit from additional datasets, beyond carbon intensity, the further away from perfect climate metric correlation. The further from perfect the correlation, the higher the potential diversification benefit of including additional climate and sustainability factors.

Exhibit 7 shows that climate factors are largely low or negatively correlated, thus confirming the theoretical idea that the addition of multiple climate factors may yield informational advantage in assessing a company's potential climate risks and opportunities.

[12] The EU Climate Transition and Paris-Aligned Benchmarks: A New Paradigm (2019)

[13] The Active Manager's Conundrum (2020)

[14] Asset Class Correlations Affect Portfolio Volatility and Return (2018)

[15] The Merits and Methods of Multi-Factor Investing (2018)

[16] The Importance of Sector Diversification in a Yield-Focused Strategy – Part I (2018)

Exhibit 7: Climate Factors Correlation

Correlation	Carbon Intensity	Transition Pathway	Fossil Fuel Reserves Intensity	ESG Score	Green-to-Brown Share	Physical Risk	High Impact Revenue	Carbon Disclosure	Benchmark Index Weight	Liquidity
Carbon Intensity	1	0.16	0.31	0.08	-0.13	0.12	0.27	0.1	-0.03	-0.02
Transition Pathway	0.16	1	-0.01	0	-0.07	0.14	0.18	0.05	-0.02	-0.02
Fossil Fuel Reserves Intensity	0.31	-0.01	1	-0.01	-0.03	0.04	0.03	0.03	-0.01	-0.01
ESG Score	0.08	0	-0.01	1	0.04	-0.07	0.02	0.43	0.09	0.02
Green-to-Brown Share	-0.13	-0.07	-0.03	0.04	1	-0.01	-0.04	-0.45	-0.01	-0.06
Physical Risk	0.12	0.14	0.04	-0.07	-0.01	1	0.16	0.07	-0.08	-0.07
High Impact Revenue	0.27	0.18	0.03	0.02	-0.04	0.16	1	0.09	-0.07	-0.06
Carbon Disclosure	0.1	0.05	0.03	0.43	-0.45	0.07	0.09	1	0.09	0.05
Benchmark Index Weight	-0.03	-0.02	-0.01	0.09	-0.01	-0.08	-0.07	0.09	1	0.64
Liquidity	-0.02	-0.02	-0.01	0.02	-0.06	-0.07	-0.06	0.05	0.64	1

Source: S&P Dow Jones Indices LLC, S&P Global Trucost, S&P Global Sustainable1 and FactSet. Data as of June 30, 2023. Table is provided for illustrative purposes.

Two pairs of climate factors have higher correlations. Carbon disclosure and the ESG score show a correlation of 0.43, which is unsurprising, as ESG scores tend to reward companies for greater disclosure, incentivizing corporations to report more in order to gain higher scores. Carbon intensity also has a 0.31 correlation with fossil fuel reserves, which also makes intuitive sense—companies that own these assets are more likely to burn them as part of their value chain, therefore being included as Scope 3 emissions.

How Are Eligible Companies' S&P PACT Weights Determined?

A random forest algorithm is used to model PACT constituents' active weights, to provide insights as to the relative importance of sustainability factors within the S&P DJI's glass-box optimization. A random forest model is preferred over linear regression, as it is able to capture the non-linear nature of the optimization when determining the weights of PACT constituents. This technique is also less sensitive to outliers and less prone to overfitting, a property by design, which makes it a robust technique to assess the relative importance of sustainability factors within PACT reweighting.

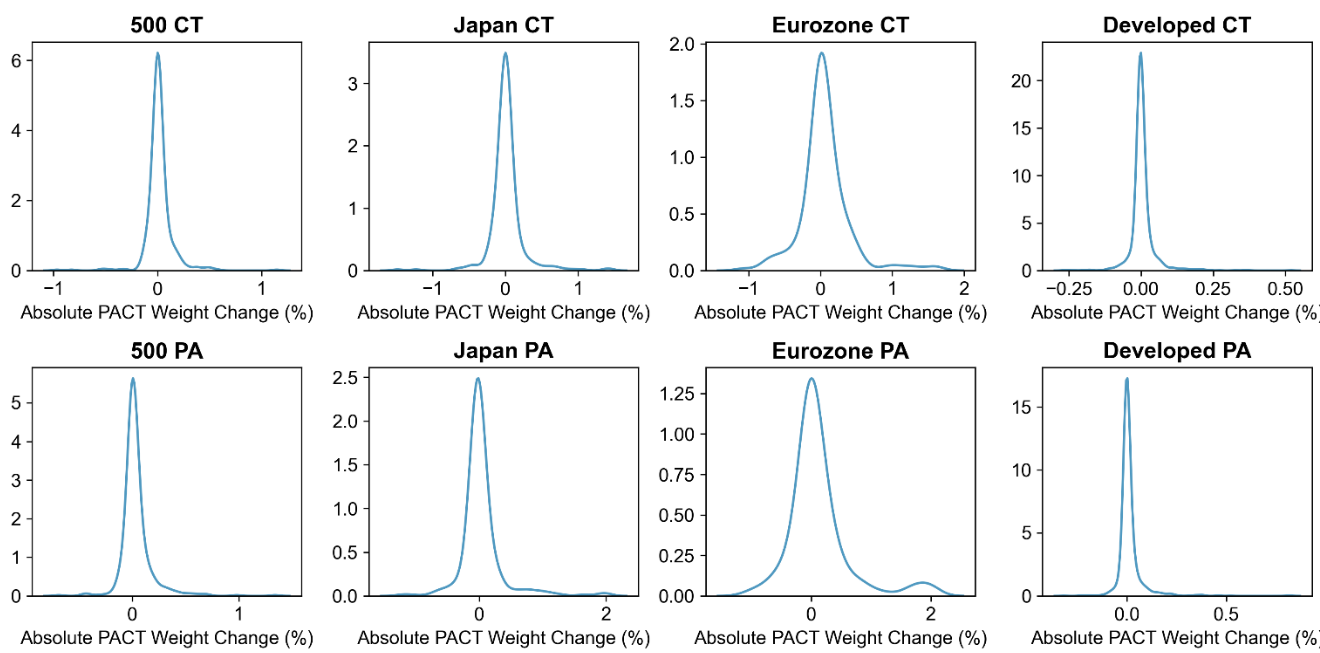
The objective function and constraints are drivers of weight change. Some capping constraints are either not, or rarely, utilized, while for the Science Based Targets constraint, no companies across the universes analyzed meet eligibility criteria for overweighting. Other constraints are used as regression variables to explain the percentage weight change.

Index Construction Constraints

Exhibit 8 shows just three companies across all universes, within the S&P Eurozone PA Index, were capped for a relative stock weight of ±2%. The constraint only affected three stocks across regions and therefore had minimal impact on S&P PACT Index weights. Likewise, only four companies across S&P PACT Index variants had their weight capped at the maximum of either 5% or their original underlying weight. These constituents would likely have received more weight than they were allocated by the S&P PACT Indices without the cap. Of these four, three companies had more than 5% weight in one of the underlying benchmark indices (see Exhibit 9).

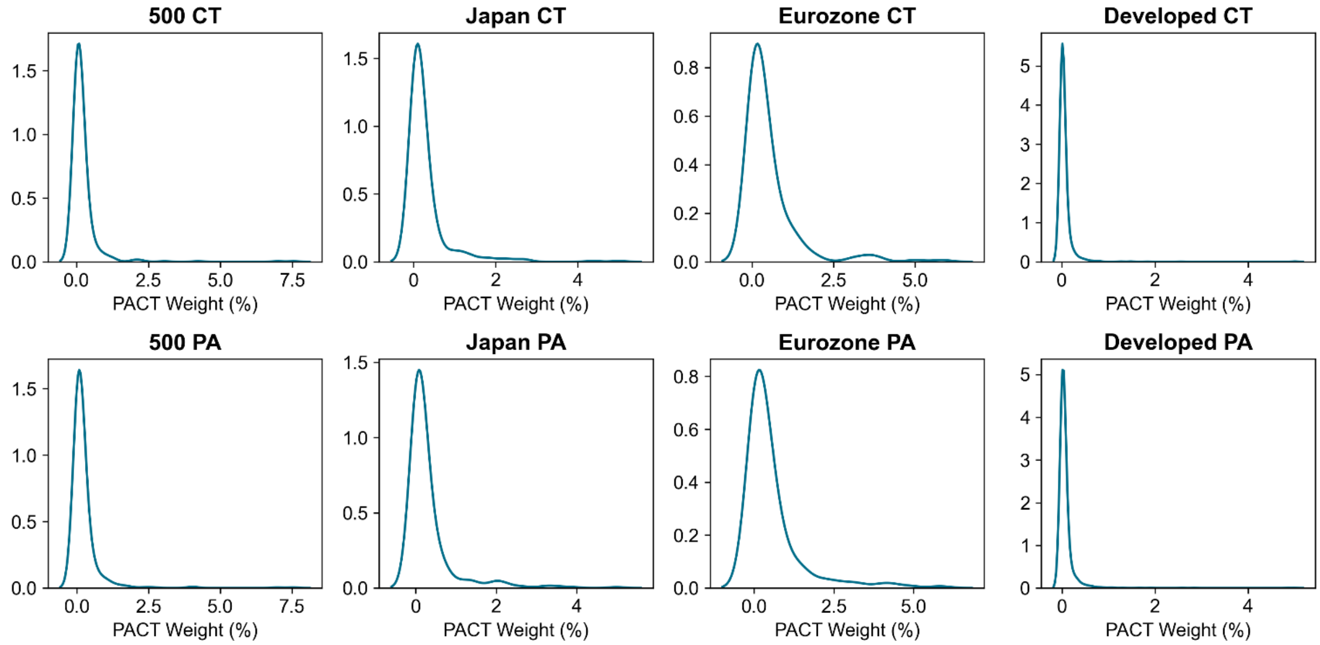
The lower threshold constraint for minimum stock weight can be understood by an interaction between constituents' benchmark weight and climate factors. The lower the companies' benchmark weight and the worse the company performs on climate factors, the more likely the 1 basis point threshold will be hit, with the subsequent removal of those companies.

Exhibit 8: Absolute S&P PACT Index Weight Change Distributions



Source: S&P Dow Jones Indices LLC. Data as of June 30, 2023. Charts are provided for illustrative purposes.

Exhibit 9: S&P PACT Index Weight Distributions



Source: S&P Dow Jones Indices LLC. Data as of June 30, 2023. Charts are provided for illustrative purposes.

Climate Factors and Benchmark Index Weight Effects

The climate factors and benchmark index weight are standardized to create a comparable scale among variables. As carbon disclosure is binary, this variable is not standardized. We regress standardized climate factors on the relative weight change (PACT weight divided by underlying index weight) to understand their impact on S&P PACT Index weights within the eligible universe—those stocks left after exclusion (see Equation 5).

This method is not too dissimilar from using the regression-based Fama-French model to attribute performance to equity risk factors,[17] the difference being in what we are trying to explain and with what factors. Theoretically, there are similarities.

Equation 5: PACT Relative Weight Change

$$Weight\ Change_i = \frac{PACT\ Weight_i}{Benchmark\ Weight_i}$$

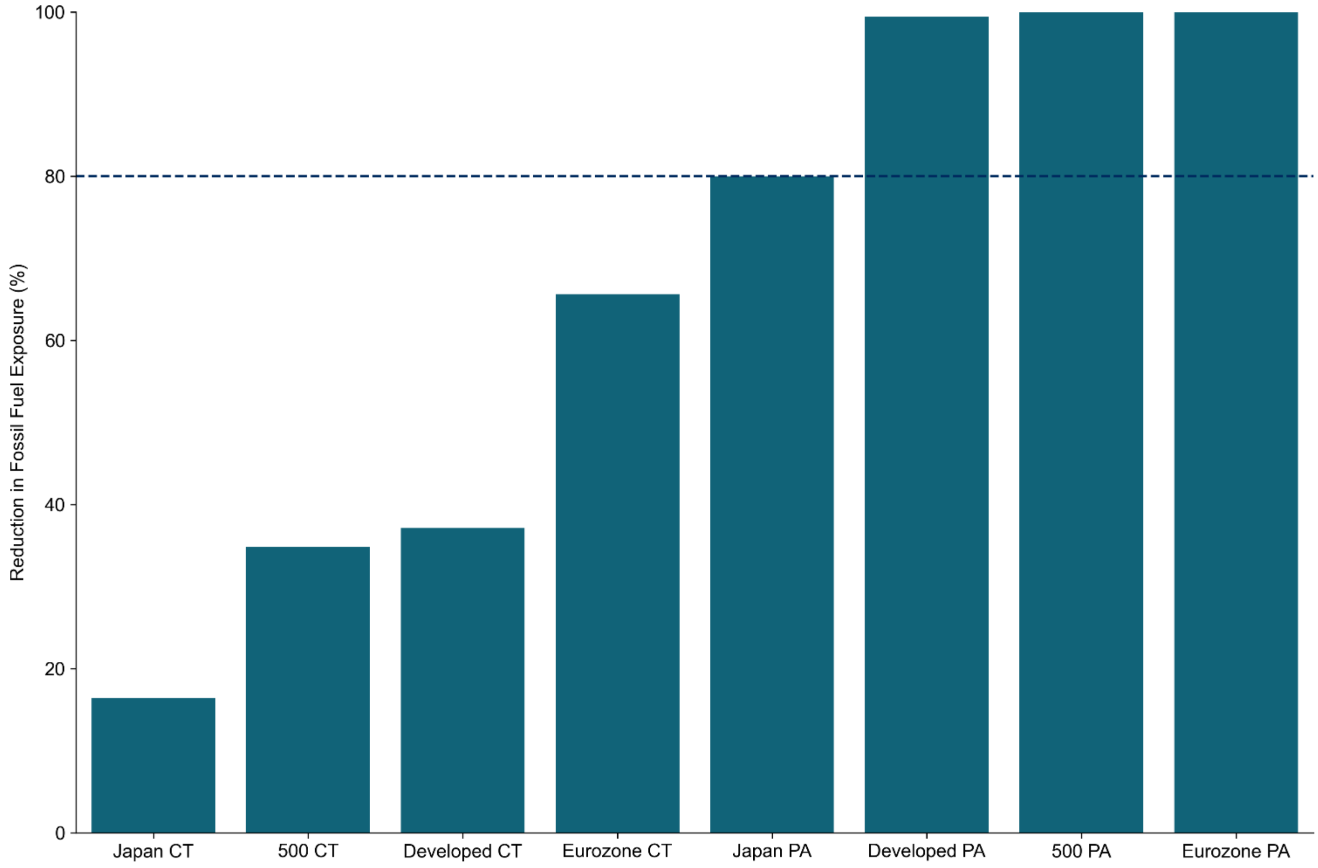
Equation 6: PACT Percentage Weight Change

$$Percentage\ Weight\ Change_i = \frac{PACT\ Weight_i - Benchmark\ Weight_i}{Benchmark\ Weight_i} \times 100$$

[17] Asset pricing models used to attribute performance to equity risk factors (1997) (2015) (1992)

We include fossil fuel reserves in these climate factors, but its impact is estimated to be minimal or even negligible, as we observe that the fossil fuel reserve reduction goes beyond the required constraints (80% reduction for S&P PA Indices and no worse for S&P CT Indices), as seen in Exhibit 10. This is likely due to interactions between other climate factors, exclusions and fossil fuel reserves. We conclude that fossil fuel reserves have no significant impact on S&P PACT Index weights and are employed as a safety net to control future exposures.

Exhibit 10: Fossil Fuel Reduction/Control



Source: S&P Dow Jones Indices LLC. Data as of June 30, 2023. Chart is provided for illustrative purposes.

The aim of the analysis is to attribute the percentage change (see Equation 6) in S&P PACT Index weight to the benchmark weight and climate factors. This enables understanding of what companies can improve from a climate perspective, in order to gain a higher S&P PACT Index weight.

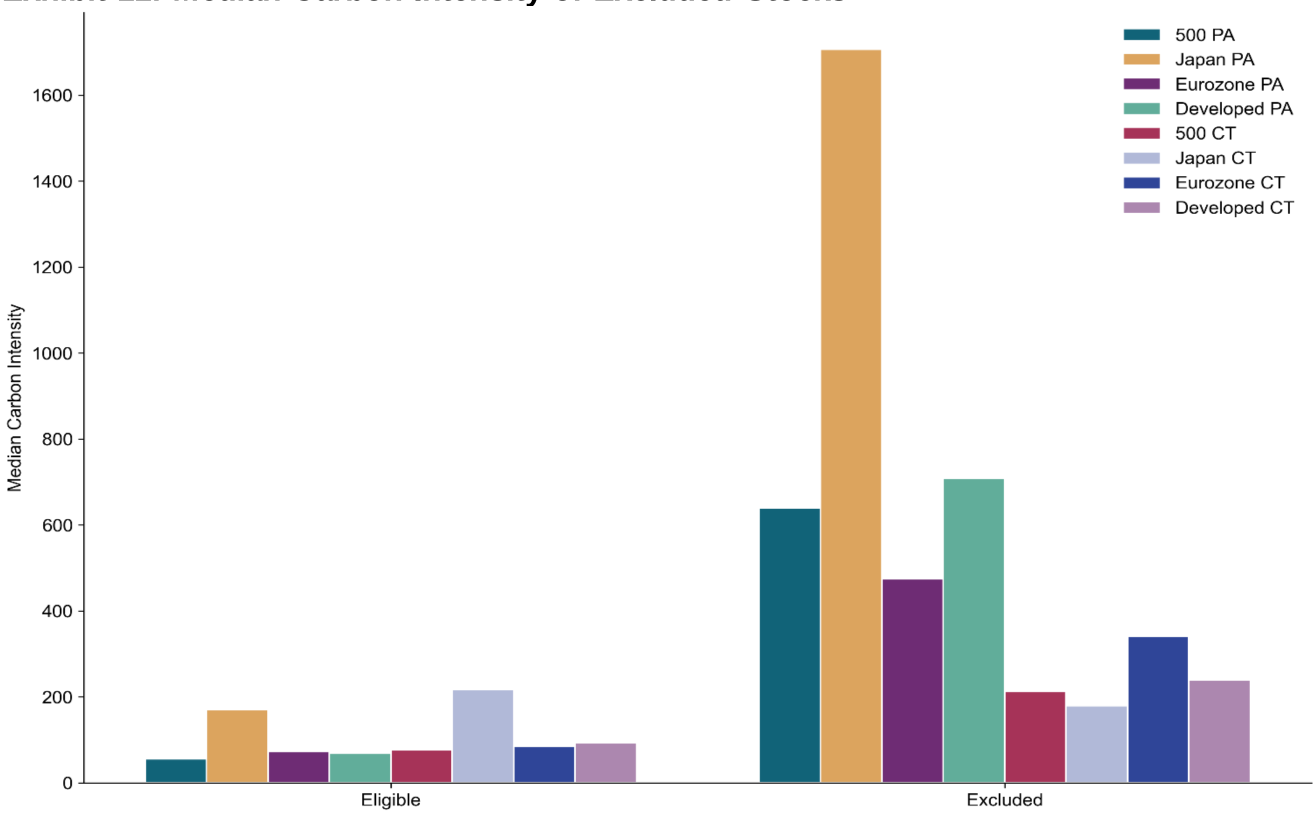
The transition pathway, carbon intensity, ESG score, physical risk and high climate impact show the largest effect on percentage changes in constituent weights, while interaction effects between factors and exclusions likely play a significant role.

Carbon Intensity Effect

As the S&P PACT Indices aim to reduce both relative and absolute carbon intensity, we observe this factor to be playing a prominent role, through the interaction between exclusions and reweighting. Exhibit 11 shows the difference in median carbon intensity of excluded versus eligible stocks. This indicates a carbon intensity reduction caused by exclusions, which contributes to the 30% and 50% carbon intensity reductions required for the S&P CT Indices and S&P PA Indices, respectively.

Additionally, carbon intensities have a high positive skew, as seen in Exhibit 6. Consequently, the index can be substantially decarbonized by underweighting a small number of companies. Carbon intensity also has a low but positive correlation to the transition pathway model—an interaction effect here may help reduce carbon intensity.

Exhibit 11: Median Carbon Intensity of Excluded Stocks



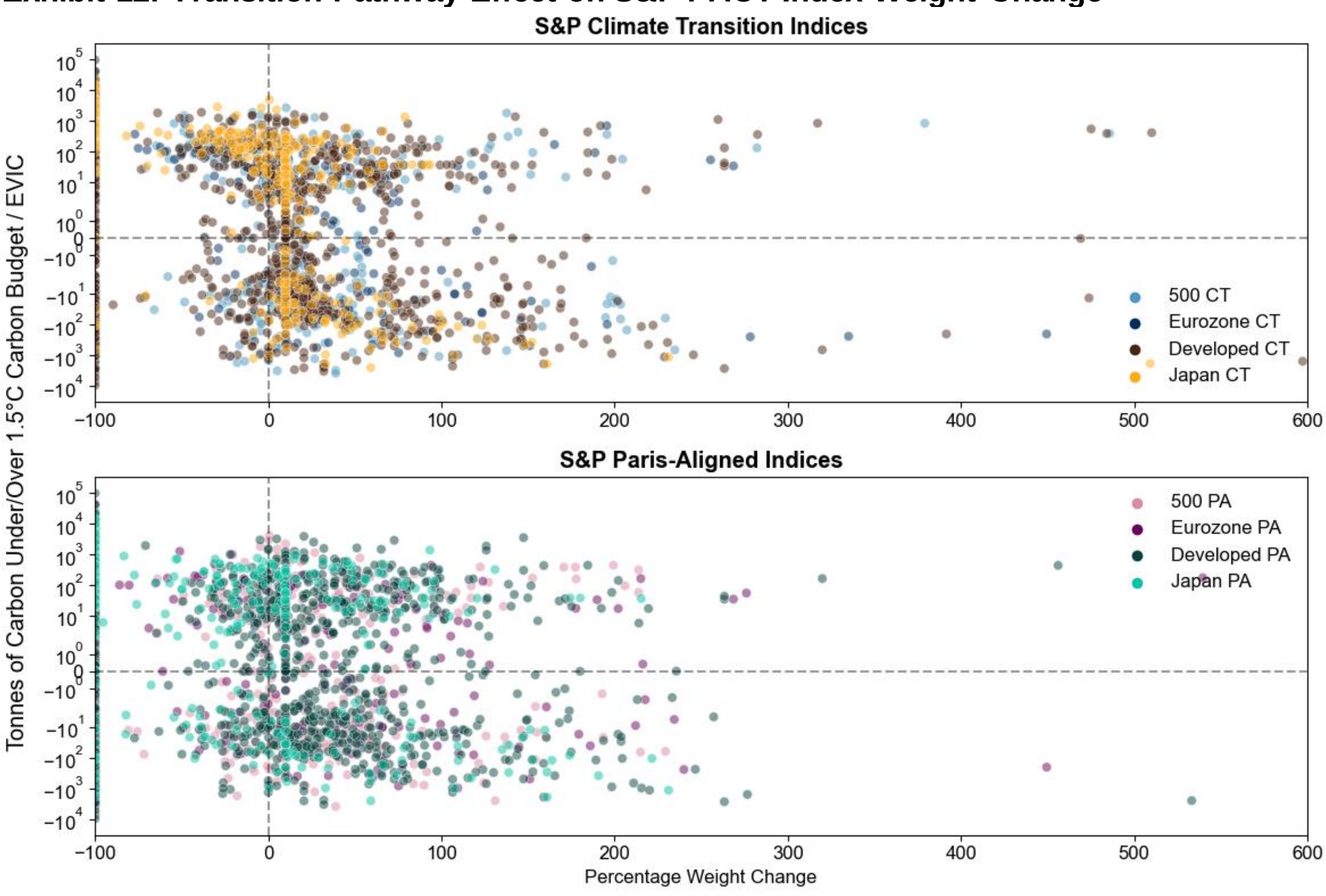
Source: S&P Dow Jones Indices LLC and S&P Global Trucost. Data as of June 30, 2023. Chart is provided for illustrative purposes.

Between the positive skew of carbon intensity data and potential interaction effect between the carbon intensity of companies and the exclusions, carbon intensity still has a significant effect on the percentage weight change of S&P PACT Indices constituents. This is because the index aims to follow an absolute self-decarbonization of 7% year-over-year and as carbon reduction requirements grow, more weight needs to be taken from less carbon intense companies to achieve the decarbonization constraints.

Transition Pathway Effect

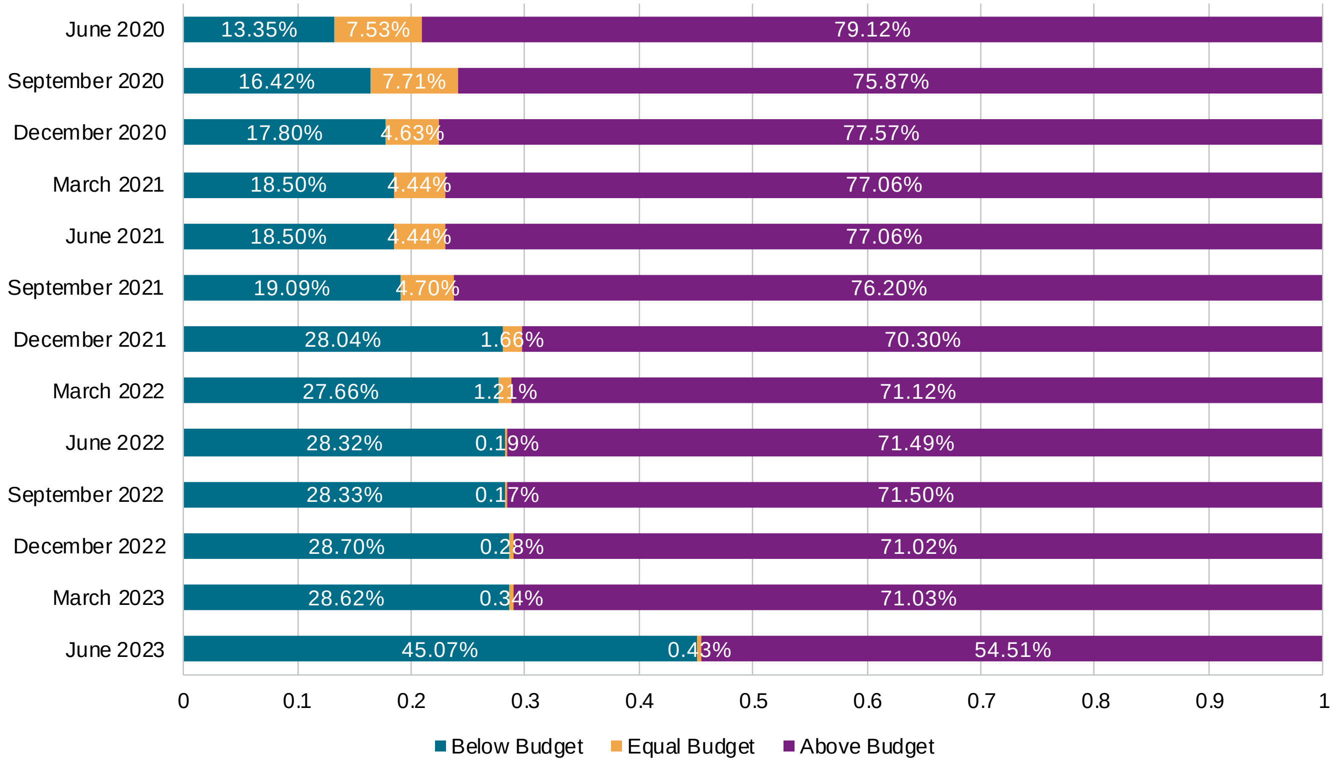
A company's trend of carbon intensity plays an important role when looking at the transition pathway of companies. For each region, the transition pathway is significant and impactful on S&P PACT Index weights. Exhibit 12 shows the relationship between the transition pathway (on a logarithmic scale) and the percentage weight change between a constituent's weight in the PACT Indices and its respective weight on the parent benchmark. Generally, there is an overweight of companies that are significantly under their 1.5°C budget—those at the bottom right of the chart—and underweight of those above their 1.5°C budget. However, the relationship between companies' carbon budget and their respective over/underweight has evolved since the S&P PACT Indices have launched, as the proportion of companies (by market cap) below their carbon budget has increased since the first live rebalance (see Exhibit 13).

Exhibit 12: Transition Pathway Effect on S&P PACT Index Weight Change



Source: S&P Dow Jones Indices LLC and S&P Global Trucost. Data as of June 30, 2023. Charts are provided for illustrative purposes.

Exhibit 13: More Companies Are Aligned with Their 1.5°C Carbon Budget Than in June 2020



Source: S&P Dow Jones Indices LLC and S&P Global Trucost. Data from June 2020 rebalance to June 30, 2023, rebalance, based on S&P Developed ex-Korea LargeMidCap universe. Proportion shown by market cap. Chart is provided for illustrative purposes.

The non-linearity of weight distribution from the optimizer illustrates the efficiency gains of optimization over a less-sophisticated approach. This does, however, mean using linear regression to attribute weight changes to climate factors is imprecise. This is why we model PACT active weights using a random forest algorithm, which better captures the non-linear relationship between the data inputs and the resulting PACT constituent weights.

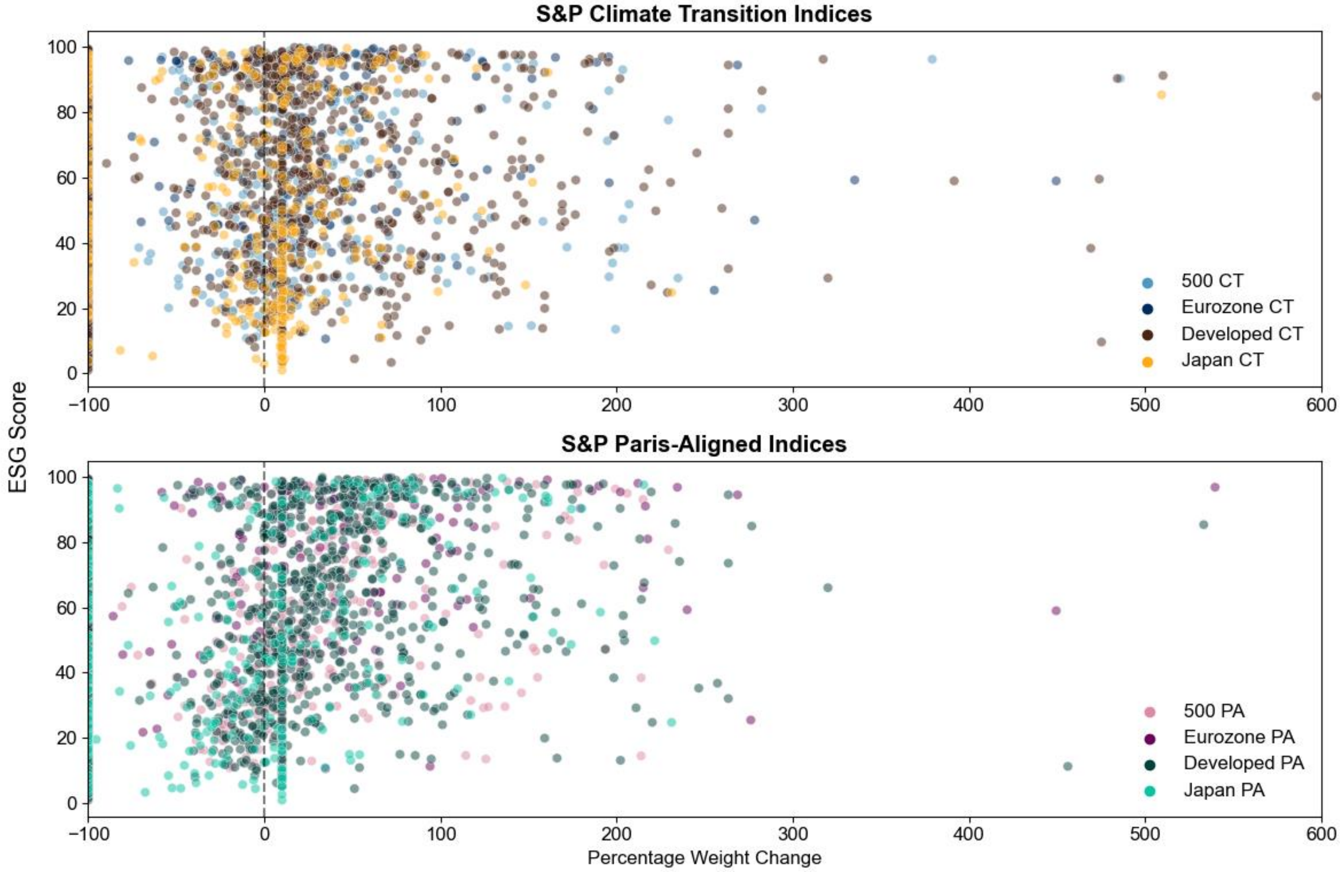
Similar to carbon intensity, the transition pathway is an absolute constraint. Consequently, the impact the transition pathway has on the index may change over time depending on the number and extent of companies that are aligned with the transition (or lack thereof).

ESG Score Effect

ESG score shows a significant impact on the percentage weight change of S&P PA Index constituents, while being mostly insignificant in explaining the weight change of S&P CT Index constituents (with the exception of Developed CT). This effect is owing to the 20% ESG score improvement constraint within the S&P PA Indices, while the S&P CT Indices aim to be no worse.

Exhibit 14 demonstrates the difference in ESG score impact on company weights between the S&P CT and PA Indices. Constituents with higher scores, on average, observe higher increases in weight than their lower-scoring counterparts.

Exhibit 14: ESG Score Effect on S&P PACT Index Weight Change



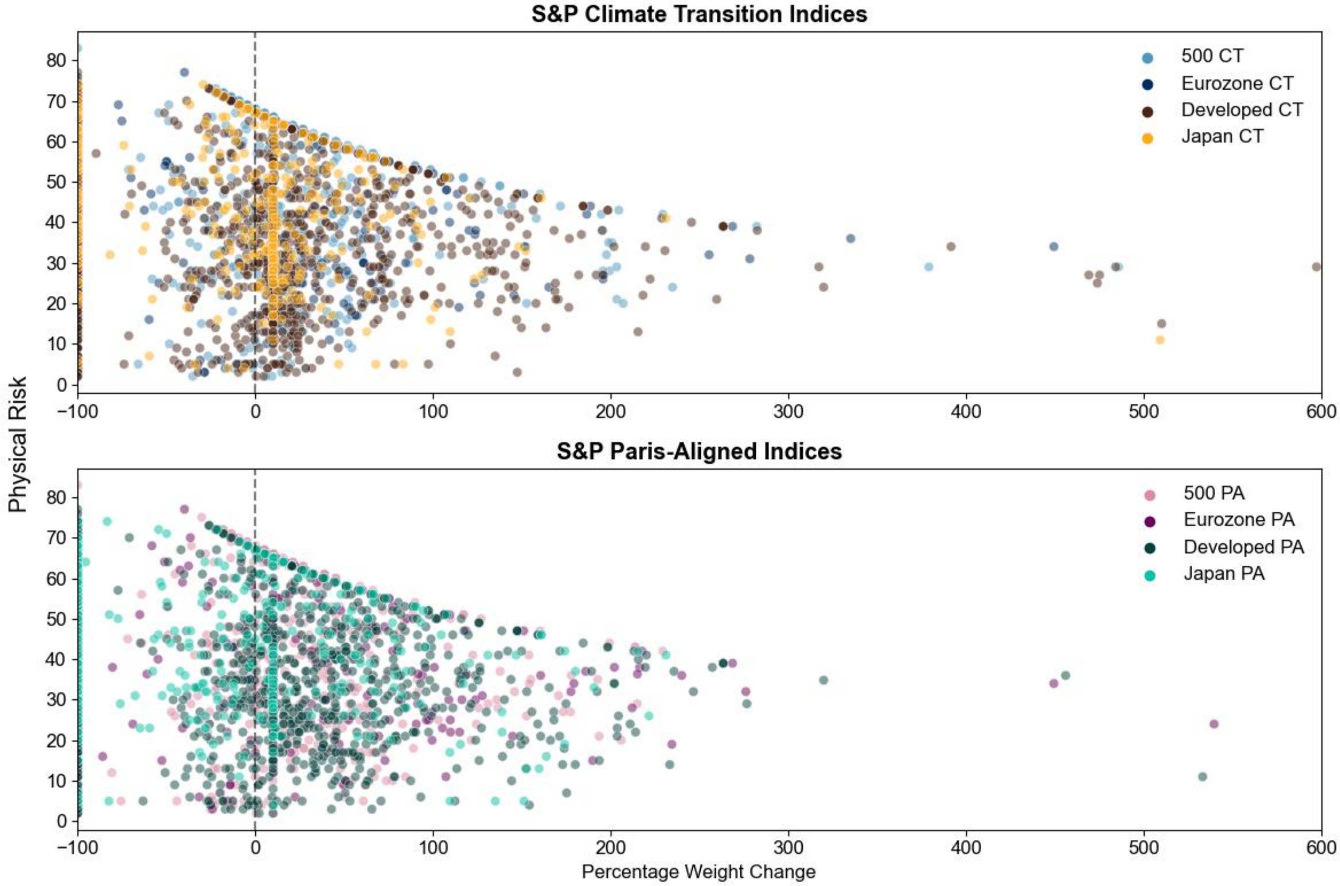
Source: S&P Dow Jones Indices LLC and SAM, part of S&P Global. Data as of June 30, 2023. Charts are provided for illustrative purposes.

Physical Risk Effect

Physical risk shows a significant, meaningful impact on constituent reweighting across most S&P PACT Indices. Exhibit 15 presents the dynamic physical risk cap, observed as the curve topping each chart. This cap is in place to reduce acute physical risks—event-driven risks that may represent significant tail risk to companies. To reduce potential risk, the S&P PACT Indices cap constituent weights based on their physical risk score. A company with high exposure and high sensitivity to any one underlying physical risk will have an aggregated physical risk higher than the 95th percentile physical risk score of the underlying index.

Consequently, the S&P PACT Indices are designed so a company with a physical risk corresponding to the 95th percentile of the parent index sees its weight capped at its benchmark index weight (i.e. this company cannot receive an overweight). This curve rises as the physical risk increases, capping those with higher risk more severely. The physical risk cap appears to have a larger impact than the weighted average reduction.

Exhibit 15: Physical Risk Cap Effect on S&P PACT Index Weight Change



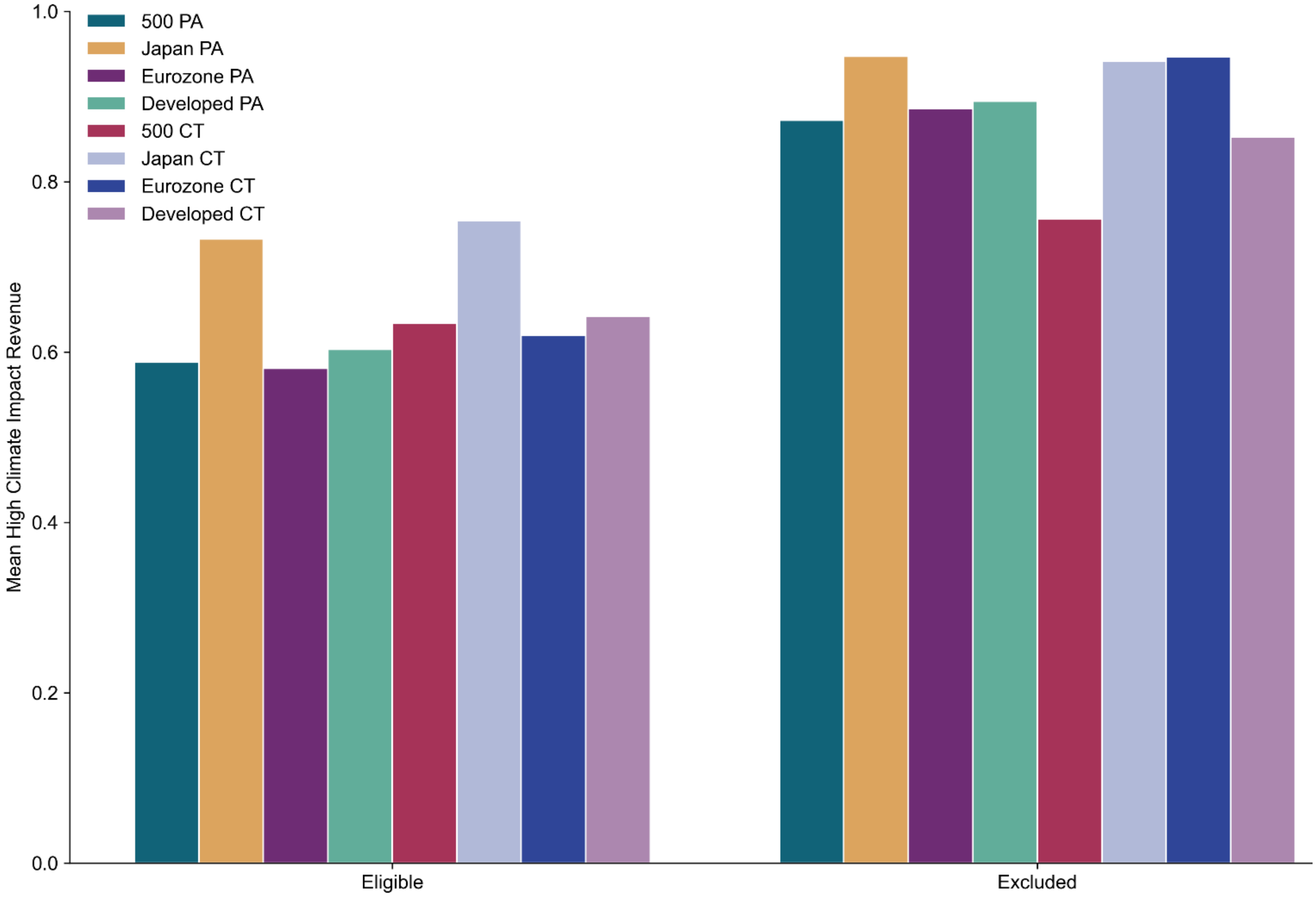
Source: S&P Dow Jones Indices LLC and Trucost, part of S&P Global. Data as of June 30, 2023. Charts are provided for illustrative purposes.

High Climate Impact Revenues Effect

The high climate impact constraint exemplifies the interaction effect between exclusions and climate factors. Exhibit 16 shows that, within each index, the mean high climate impact revenue of excluded constituents is higher than that of their eligible peers.

To avoid greenwashing, the indices are constrained to ensure, at rebalance, they have no fewer high climate impact revenues than the benchmark. The exclusion of companies with more high climate impact revenues means constituents with high climate impact revenues will need to be overweighted more heavily, on average, relative to those with few or no high climate impact revenues. This is particularly true for the S&P PA Indices, where the exclusion based on fossil fuels intensifies the need to overweight companies with high climate impact revenues.

Exhibit 16: Mean High Climate Impact Revenue Percentage of Excluded Constituents

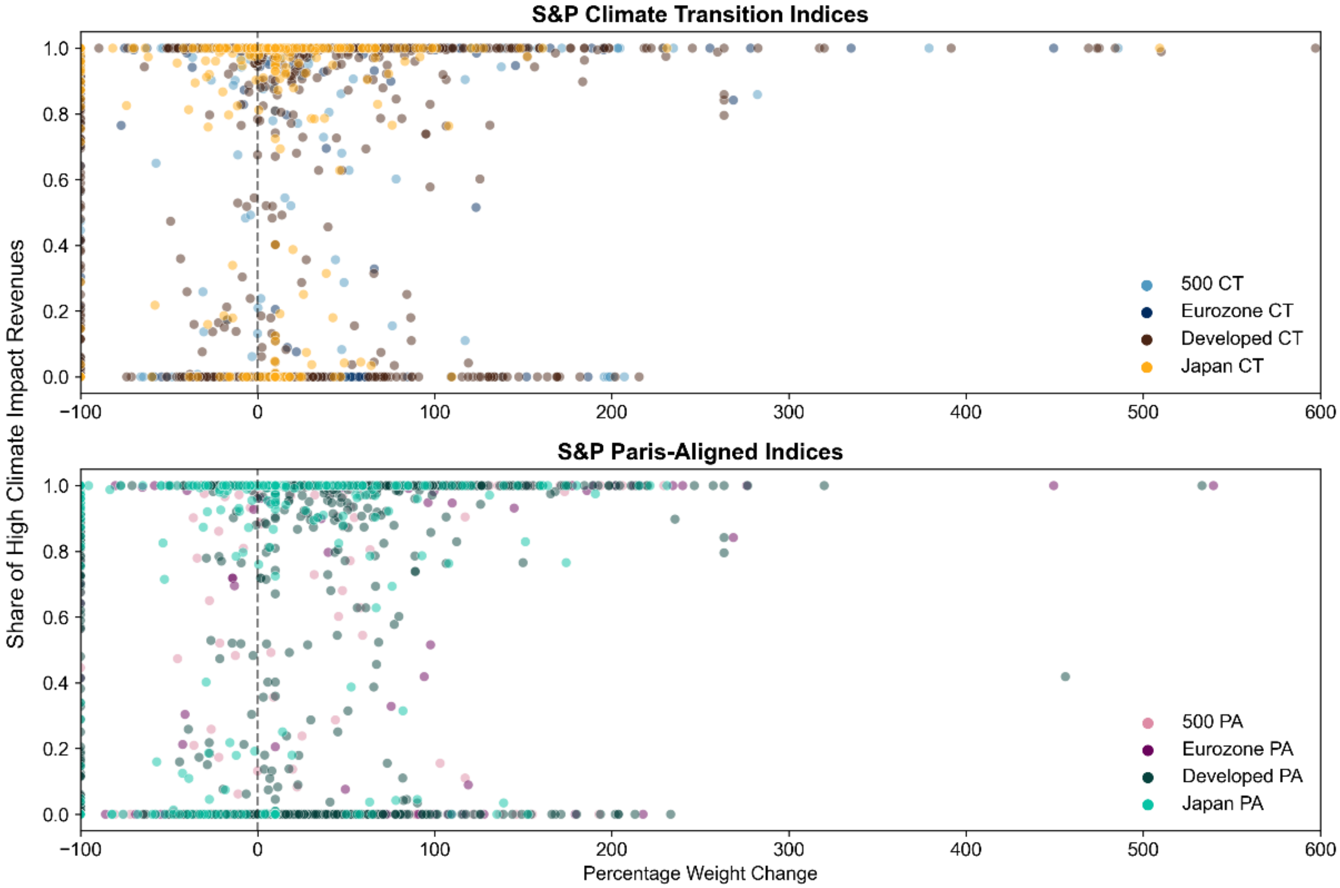


Source: S&P Dow Jones Indices LLC and S&P Global Trucost. Data as of June 30, 2023. Chart is provided for illustrative purposes.

In Exhibit 17 we can grasp the extent of overweighting potential for those constituents that have most revenues from high climate impact revenue streams. Those with substantially more than 100% overweight all have high impact revenue streams, with some of these being overweighted by almost 600%, relative to the benchmark index.

When this is considered, it is unsurprising to see high climate impact revenues significantly and meaningfully affect S&P PACT Index constituent weight change.

Exhibit 17: High Climate Impact Effect on S&P PACT Index Weight Change



Source: S&P Dow Jones Indices LLC and S&P Global Trucost. Data as of June 30, 2023. Charts are provided for illustrative purposes.

Benchmark Index Weight Effect

Weight that is excluded needs to be redistributed among eligible stocks, and due to the objective function, larger companies have more potential for weight change. On average, companies must receive an overweight so the index weights sum to one, and companies with higher weight in the benchmark index have greater potential for overweight; therefore we would expect larger companies, on average, to receive a higher weight increase. This allows the index to minimize any size bias and more closely reflect the characteristics of a market-cap-weighted index.

Also, there is an asymmetry of relative weighting—companies can only have a 100% relative underweight, as this is a long-only strategy, but there are stocks overweighted by over 600%. This may further add to the impact of benchmark index weight on S&P PACT Indices weights, due to the objective function.

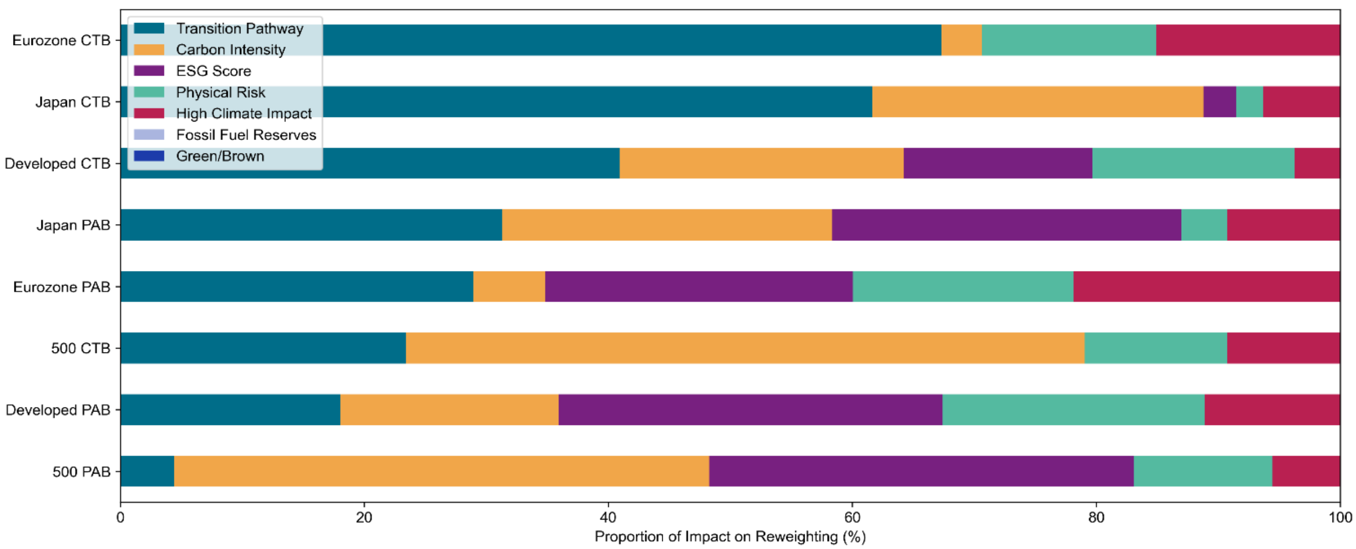
How Can Companies Improve Their S&P PACT Index Weight?

For companies to understand how they can gain more weight within S&P PACT Indices, they need to understand the two simple principles laid out in Exhibit 1.

– Exclusion: Is a stock eligible for the index?
– Reweighting: How does a stock perform from a climate perspective?

Simply put, if companies want to improve their weight in the indices, they can't be excluded and must perform well on the climate metrics driving the S&P PACT Index methodology. The transition pathway, carbon intensity, ESG score, physical risk and high climate impact have the greatest effect on constituent weight changes, as can be seen in Exhibit 18. A random forest algorithm was used to model PACT active weights in order to understand what drives the PACT reweighting effect.[18]

Exhibit 18: Relative Impact on Percentage Weight Change for Each Sustainability Factor



Source: S&P Dow Jones Indices LLC, S&P Global Trucost and S&P Global Sustainable1. Data as of June 30, 2023. Chart is provided for illustrative purposes.

The factors to focus on are the transition pathway, carbon intensity, ESG score and physical risk. Companies' high climate impact revenues are due to their business activities rather than climate factor performance.

The transition pathway is driven by the carbon intensity trend of companies. Companies within the cement, power generation, steel, air transportation or aluminum sectors, as defined by the

[18] Some of the benefits of using a random forest algorithm over linear regression models include stronger explanatory power, due to its ability of capturing non-linear relationships, and low sensitivity to model tuning. Please see Explaining Optimized Weights for more information.

Sectoral Decarbonization Approach (SDA), have unique decarbonization pathways.[19] Companies not within these SDA sectors are required to reduce their carbon-to-gross-profit footprint by 7% year-over-year, after adjusting for inflation, in line with the greenhouse gas emissions per unit of value added (GEVA) approach.[20]

To improve the ESG score, a company should focus on the identification of key sustainability risks, articulation of relevant mitigation and opportunity strategies, and disclosure against key risks, mitigation strategies and opportunities.

Companies' physical risk can be reduced via the divestment of assets in highly exposed locations or the reduction of sensitivity factors, such as water intensity. This will decrease their sensitivity-adjusted physical risk score.

If companies are not excluded, there are clear paths to a higher weight in the S&P PACT Indices:

– Significant reduction in carbon intensity year-over-year;
– More disclosure around sustainability policies and metrics;
– Improvement in performance against sustainability policies and metrics; and
– Divestment of assets in locations highly exposed to physical risks.

Case Studies

Exhibit 18 highlights company-level examples of the reweighting attribution model used to explain the S&P PACT Indices, according to different climate factors for eligible companies. The table aims to provide transparency by depicting examples of how an individual stock is reweighted in the S&P PACT Indices relative to its benchmark index, based on climate and sustainability factors.

The table employs a color-coding system, in which blue shades represent relatively positive climate metric exposure, while orange tones depict weaker values compared with the benchmark index counterparts. For instance, where a strong transition pathway factor (blue) is achieved through being below the 1.5°C carbon budget on a forward-looking basis, the opposite is true for the ESG score, in which a higher value (blue) denotes a better overall score. Similarly, while a lower physical risk score (blue) drives stock overweight, a lower green-to-brown revenue ratio (gray) negatively impacts weighting, especially in the Utilities sector. We go on to provide a comparison of pairs of companies within the same sub-industry to further provide transparency around the impact of climate factors on its relative S&P PACT Index weighting.

[19] Sectoral Decarbonization Approach (SDA): A method for setting corporate emission reduction (2015)

[20] Greenhouse gas emissions per unit of value added ("GEVA") – A corporate guide to voluntary climate action (2012)

Exhibit 18: Reweighting of Individual Stocks in the S&P PACT Indices Based on Sustainability Factors

Company	Sub Industry	Carbon Intensity	Carbon Disclosure	Green-to-Brown Revenue Share	High Climate Impact Revenues	ESG Score	Physical Risk	Transition Pathway	Benchmark Index Weight (%)	PA Weight Change (%)	CT Weight Change (%)
Coca-Cola Co	Soft Drinks & Non-alcoholic Beverages	141.92	Yes		1.00	76.26	64.00	-23.46	0.66	21.13	21.13
PepsiCo Inc		195.54	Yes		1.00	81.93	61.00	0.94	0.72	38.94	38.94
Oracle Corp	Systems Software	7.29	Yes		0.08	46.56	28.00	9.77	0.47	22.31	47.48
Microsoft Corp		6.61	Yes		0.13	88.87	11.00	16.19	6.99	0.00	0.00
Exelon Corp	Electric Utilities	221.95	Yes	1.17	0.22	80.29	69.00	-837.33	0.11	-100.00	-4.54
NextEra Energy Inc		206.18	Yes	1.12	1.00	31.52	70.00	1924.05	0.42	-100.00	-9.15
Tesla, Inc	Automobile Manufacturers	42.45	Yes		0.97	33.15	49.00	-11.25	1.57	18.82	29.85
Ford Motor Co		1488.96	Yes		0.93	49.08	23.00	27.90	0.13	-100.00	-100.00

Source: S&P Dow Jones Indices LLC, S&P Global Trucost and S&P Global Sustainable1. Data as of June 30, 2023. Table is provided for illustrative purposes.

In the Soft Drinks & Non-Alcoholic Beverages sub-industry, we see both Coca-Cola and Pepsi Co. being overweighted, albeit to different degrees. While both companies are either below or very close to their corresponding carbon budget for 1.5°C, Pepsi Co.'s stronger sustainability profile, as represented by its ESG Score, and its lower physical risk resulted in it being awarded a bigger weight boost.

Within Systems Software, Oracle was given an overweight, while Microsoft saw its weight unchanged from its underlying index. Oracle's lower exposure and vulnerability to physical risk, close alignment with its 1.5°C carbon budget and relatively low carbon intensity resulted in a 22.31% boost within the PA index and a 47.48% increase within the CT index. Microsoft, while showing strong credentials across sustainability and climate factors, saw its weight capped at the original underlying index weight, a rule applied to ensure diversification within the PACT indices.

Within Electric Utilities, both Exelon and NextEra Energy were given zero weight in the PA Indices and given an underweight in the CT Indices. Exelon's high ESG score and alignment with its carbon budget were offset by relatively high physical risk, resulting in its underweight to fall below the 1 basis point threshold, so it received zero weight. NextEra's underweight was a result of its low ESG score, high exposure to physical risk and misalignment with its allocated carbon budget on a forward-looking basis.

Tesla and Ford, two of the biggest global automakers, also experienced different weightings within the PACT indices. Despite Tesla's weaker ESG score, the company still managed to get a weight boost due to being below its forward-looking 1.5°C carbon budget, relatively lower carbon intensity and its high proportion of high climate impact revenues. Ford, on the other hand, was given zero weight within the PACT indices, and so underweighted by 100%, mostly driven by its high carbon intensity.

Conclusion

The weighting methodology of the S&P PACT Indices can be split into two main parts—the effect exclusions play and a reweighting effect. The exclusion effect counts for around 20% of the weight differences for S&P CT Indices, while for the more ambitious S&P PA Indices, exclusions account for 35%-65% of deviations from benchmark weights. This equates to 1-5% of weight being excluded from the S&P CT Indices and 11%-15% from the S&P PA Indices from the universes assessed.

The reweighting effect is driven by sustainability, climate and index construction factors, each of which is affected by the strength of the constraint, distribution of underlying climate datasets and correlation of different climate factors. Within the reweighting effect, the transition pathway, carbon intensity, ESG score, physical risk and high climate impact revenues a company has are the key drivers of percentage weight changes observed in S&P PACT Index constituents. The diversification of high quality climate factors may add an informational advantage due to their low correlations.

For companies to gain a higher weight in the S&P PACT Indices, they should first ensure they meet the eligibility criteria. If eligible, for a larger weight in the index, companies can reduce year-over-year carbon intensity, disclose more around sustainability policies and metrics, improve performance against sustainability policies and metrics, and reduce assets' exposure to locations highly exposed to physical risks.

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Appendix

Appendix A: Transition Pathway Calculation

The Transition Pathway Budget Alignment (TPBA) of each company i is calculated as the sum of the difference between the company's carbon budget and emissions (either realized or predicted), using both historical and future projections. A TPBA of 0 would be compatible with a 1.5°C climate scenario, a budget below 0 would be compatible with a better than 1.5°C climate scenario, and a budget above 0 would not be compatible with a 1.5°C climate scenario. The alignment of the index is calculated as follows.

Equation 7: Index Alignment

$$\sum w_i \times Winsorized\ TPBA_i$$

where: w_i = weight of the company i in the index.

Appendix B: Constraints

Exhibit 19: S&P PACT Index Constraints Relative to the Underlying Benchmark

Constraint	PAB	CTB	Data Source
Transition Risk-Related Constraints			
Weighted Average GHG Emissions per U.S. Dollar Invested (relative to 1.5°C budget)	≤ 0	≤ 0	S&P Global Trucost
GHG Emissions Intensity[21]	50% lower	30% lower	S&P Global Trucost
Decarbonization Trajectory (adjusted for enterprise value growth)	WACI must stay below the 7% year-over-year trajectory	WACI must stay below the 7% year-over-year trajectory	S&P Global Trucost
Exposure to Companies with Science-Based Targets (based on 1.5°C scenario and 7% decarbonization)	Increase collective index weight of all companies with SBTs by 20% overall	Increase collective index weight of all companies with SBTs by 20% overall	S&P Global Trucost/Science Based Targets Initiative
Fossil Fuel Reserve Exposure	80% lower	No higher	S&P Global Trucost
ESG Score	20% higher	No lower	S&P DJI ESG Scores
Revenue from High Climate Impact Sectors[22]	Maintain at least same proportion	Maintain at least same proportion	S&P Global Trucost
Weight of Non-Disclosing Companies	Capped at x 1.1	Capped at x 1.1	S&P Global Trucost
Physical Risk-Related Constraints			
Physical Risk Exposure	10% lower	No higher	S&P Global Trucost
Physical Risk Cap	Dynamic cap based on the level of physical risk of each stock	Dynamic cap based on the level of physical risk of each stock	S&P Global Trucost
Opportunity-Related Constraints			
Green-to-Brown Revenue Share from Power Generation	4x higher	No lower	S&P Global Trucost
Index Construction Rules			
Constituent Weights	±2%	±2%	-
Minimum Weight	0.01%	0.01%	-
Liquidity	Company weight capped based on an investment of EUR 1 billion and the length of time it would take to trade, based on the company's three-month median daily value traded	Company weight capped based on an investment of EUR 1 billion and the length of time it would take to trade, based on the company's three-month median daily value traded	-
Diversification	Individual stock weights capped at 5%	Individual stock weights capped at 5%	-

Source: S&P Dow Jones Indices LLC, Science Based Targets Initiative and S&P Global Trucost. Table is provided for illustrative purposes.

[21] Calculated using weighted average carbon intensity (WACI), which is measured as tCO2e divided by enterprise value including cash (EVIC), based on Trucost emissions data that account for all Scopes 1, 2, and 3 emissions from inception.

[22] High climate impact sectors are defined by the EU Technical Expert Group on Sustainable Finance (2019).

Appendix C: Climate and Index Construction Factor

Exhibit 20: Expected Relationship of Climate and Index Construction Factor with Weight Change

Climate/Index Construction Factors	Expected Relationship with Weight Change	Explanation of Expectations
Carbon Intensity	Negative	The index reduces carbon intensity by 30% (S&P CT Indices) or 50% (S&P PA Indices) at inception, then 7% year-over-year.
Transition Pathway	Negative	The Transition Pathway Model shows the benchmark indices are over their 1.5°C budget. The indices are constrained below their transition pathway budget at rebalance. There must be a reduction in the weighted average transition pathway intensity to fulfill the constraint.
Fossil Fuel Reserve Intensity	Negative	The S&P CT Indices have a fossil fuel reserve intensity requirement of no higher than the benchmark index, while the S&P PA Indices has an 80% reduction requirement at rebalance. The fossil fuel exclusions may exclude many companies with fossil fuel reserves within the S&P PA Indices. This may mean the constraint has little, if any, work to do.
ESG Score	Positive	The S&P PA Indices require an increased weighted average ESG score, whereas the S&P CT Indices require it to be no worse.
Green-to-Brown Share	Positive	The S&P PA Indices require a four times greater green-to-brown share, while the S&P CT Indices require it to be no worse.
Physical Risk	Negative	A higher physical risk score represents greater physical risk. Both the S&P PA and CT Indices have the constituent weights dynamically capped, and the S&P PA Indices also have a weighted average physical risk reduction.
High Impact Revenue	Dependent on Companies Excluded	The S&P PACT Indices are constrained to have no less revenue from high climate impact revenues than the benchmark index. Revenues from high climate impact activities will likely have higher carbon intensity and fossil fuel reserves, while having a greater transition pathway spread (due to their greater carbon intensity). Therefore, we would expect to see the S&P PACT Indices' high impact revenue at the same level or close to that of the benchmark. The S&P PA Indices exclude more companies with high climate impact revenues than low climate impact revenues, due to the fossil fuel exclusions.
Carbon Disclosure	Positive	Company weights are capped at 10% more than their benchmark weight if they do not sufficiently disclose their Scope 1 and 2 carbon intensity. Therefore, we may see a positive relationship between companies disclosing and their weight if this cap is used in practice.
Benchmark Index Weight	Positive	The objective function is minimized, and the denominator is the benchmark index weight. Therefore, the higher the company weight, the more chance there is for a change in company weight. As companies are excluded from the S&P PACT Indices, the remaining weight needs to be redistributed. On average, companies will have a higher weight in the S&P PACT Indices than in the benchmark. The combination of the need to, on average, overweight eligible companies and the potential for larger overweights of companies with a larger weight in the benchmark index means there will likely be a positive relationship between the benchmark index weight and S&P PACT Index weight change. From an index design perspective, this is because larger companies tend to have higher liquidity and capacity. Overweighting large companies to a greater extent than smaller companies is beneficial. S&P DJI's Index Investment Strategy research[23] alludes to a correlation between capacity and size. Exhibit 6 shows a 0.77 correlation between liquidity and benchmark index weight.
Liquidity	Positive	There is a dynamic liquidity cap based on three-month median value traded of the company. Therefore, more liquid companies will have a greater chance to be overweighted.

Source: S&P Dow Jones Indices LLC. Table is provided for illustrative purposes.

[23] The Value of Research: Skill, Capacity, and Opportunity (2018)

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