

Research

FTSE Russell Study on EU Paris-aligned Benchmarks

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1. Executive Summary

This paper presents the results of a FTSE Russell study examining the creation of a climate-focused FTSE All-World Paris-aligned Benchmark (PAB) Index. Such a benchmark is intended to satisfy the requirements for an EU Paris-aligned Benchmark as laid out by the EU Technical Expert Group Report on Climate Transition and Paris-aligned Benchmarks (the TEG Report)¹. We construct this benchmark using the FTSE Target Exposure framework over the 10-year period between 2009-2019.

The simulated results show that the FTSE All-World PAB Index satisfies all of the requirements set out in the TEG report, achieving an average carbon emissions reduction of over 50% compared to the benchmark FTSE All-World Index. Emissions at the end of 2019 are also reduced to half their 2009 level, satisfying the 7% year-on-year carbon emissions reduction objective. The FTSE All-World PAB Index is also able to double the proportion of green revenue compared to the FTSE All-World benchmark and incorporate forward-looking assessments of the climate risks facing companies and corporate target setting using the Transition Pathway Initiative's data (TPI)².

The industry and country weight profiles of the FTSE All-World PAB Index highlight the interaction between adjustments arising from climate targets, exclusions and sector constraints. Oil and Gas is the most underweight ICB industry, primarily as a result of exclusion requirements. Overweight positions in Technology and Industrials are principally due to the sector constraints contained in the TEG requirements. Switzerland and France / (China) are among the most overweight / (underweight) countries owing to their relatively good (poor) emissions performance and on their TPI metrics.

The FTSE All-World PAB Index achieves each of the EU Paris-aligned Benchmark requirements laid out in the TEG Report, exhibiting a tracking error of 1.2% and a two-way turnover of 17% per annum over the simulation period. The construction framework employed is general, transparent and robust, providing the foundation for regional and country level benchmarks. This approach may be readily extended to meet the requirements for Climate Transition Benchmarks (CTB) that are also detailed in the TEG Report. The CTB requirements can be seen as a special case of the PAB requirements, embodying a less taxing set of climate objectives.

¹ https://ec.europa.eu/info/publications/sustainable-finance-technical-expert-group_en

² <https://www.transitionpathwayinitiative.org/>

2. Introduction

Climate transition benchmarks have become a focal point for investors looking to integrate climate risks into their portfolios and align them with the climate goals of the Paris Agreement (or “Paris-aligned” benchmarks). This has fueled an active interest among investor groups and regulators to identify criteria that can be used to define such benchmarks.

As part of its action plan on sustainable finance, the EU tasked the Technical Expert Group (TEG) to develop recommendations for minimum requirements for benchmarks that are aligned with the objectives of the Paris Agreement and address the risk of greenwashing. The EU Technical Expert Group Report on Climate Transition and Paris-aligned Benchmarks (the TEG report), published in September 2019, and the handbook on climate benchmarks, published in December 2019, outline the proposed TEG requirements that have provided the basis for the draft delegated acts by the Commission (available as of April 2020).

For equity benchmarks, the TEG report specifies minimum requirements for a benchmark to be classified as an EU CTB and PAB. The latter set of requirements are more progressive in terms of climate targets. The TEG report lays out the trajectory for climate transition over a 10-year window beginning in 2020. The trajectory aligns with global targets aiming to reduce carbon emissions by 50% by the end of 2030. This paper examines the feasibility of constructing Paris-aligned climate transition benchmarks within the FTSE Target Exposure framework³.

The FTSE Target Exposure framework is a general tilt-based framework, which permits the construction of portfolios with specific exposure objectives encompassing factor, climate and ESG goals. Exposure objectives are flexible and may be set to achieve specific design objectives and portfolio outcomes. We use this framework to incorporate the climate transition requirements of a Paris-aligned benchmark.

In this paper, we develop a FTSE All-World PAB Index that satisfies the TEG report requirements over the 10-year period between 2009 and 2019. This paper is organized as follows:

- Section 3 summarizes the Paris-aligned benchmark requirements
- Section 4 details the mechanics of the Target Exposure approach and extends this framework to incorporate climate objectives to comply with the PAB requirements
- Section 5 evaluates the ability of our approach to consistently meet the PAB objectives
- Section 6 examines the resulting active industry and country weights of the FTSE All-World PAB Index
- Section 7 examines the performance of the simulated FTSE All-World PAB Index over the 10-year period to 2019
- Section 8 presents our conclusions

³ For details of the FTSE Target Exposure indexes, see <https://www.ftserussell.com/ftse-target-exposure-indexes>

3. Paris-aligned Benchmark (PAB) and Climate Transition Benchmark (CTB) Requirements

The PAB and CTB requirements for equity benchmarks focus on emissions, activities, green revenues and corporate target setting. We summarize the minimum requirements set out in the TEG report to be reflected in the design of the FTSE PAB and CTB Indexes in Table 1.

Table 1: FTSE PAB and CTB Index Objectives

Description	PAB Index Objectives	CTB Index Objectives
Minimum Emission Intensity Reduction	The lower of a 50% reduction in carbon emission intensity compared to the benchmark or a 7% year-on-year reduction in carbon emission intensity	The lower of a 30% reduction in carbon emission intensity compared to the benchmark or a 7% year-on-year reduction in carbon emission intensity
Minimum Carbon Reserve Reduction	The lower of a 50% reduction in carbon reserves compared to the benchmark or a 7% year-on-year reduction in carbon reserves	The lower of a 30% reduction in carbon reserves compared to the benchmark or a 7% year-on-year reduction in carbon reserves
Core Exclusions	<ul style="list-style-type: none"> Controversial Weapons UN Global Compact 	Not applicable
Activity Based Exclusions	<ul style="list-style-type: none"> Tobacco Coal (1%+ revenues) Oil (10%+ revenues) Natural Gas (50%+ revenues) Electricity Producers with carbon intensity lifecycle GHG emissions greater than 100gCO₂e/kWh <p>Or</p> <ul style="list-style-type: none"> Electricity Producers (50%+ revenues) 	Not applicable
Highly Exposed Sectors	Zero aggregate active weight relative to the benchmark (See Table A in Appendix I for details)	Zero aggregate active weight relative to the benchmark (See Table A in Appendix I for details)
Minimum Green Revenue ⁴	100% increase relative to the benchmark	100% increase relative to the benchmark
Corporate Target Setting	<ul style="list-style-type: none"> Improvement in TPI Management Quality Score Improvement in TPI Carbon Performance Score 	<ul style="list-style-type: none"> Improvement in TPI Management Quality Score Improvement in TPI Carbon Performance Score

⁴ As of the April 2020 Draft regulation, Green Revenue is no longer a part of the minimum requirement for the Paris-aligned benchmark.

The PAB and CTB requirements seek to align benchmarks with de-carbonization goals that achieve a 50% reduction in carbon emissions over a ten-year period (i.e. 7% per annum), in addition to a minimum 50% and 30% reduction respectively in carbon emissions relative to a reference benchmark.

The draft EU regulation published in April 2020 no longer specifies a mandatory requirement to improve exposure to companies with significant sources of Green Revenue. However, Green Revenue is a strong indicator of industrial and corporate activity that is supportive of a low carbon future. Therefore, we chose to include an additional Green Revenue goal as part of the FTSE All-World PAB and CTB index design objectives.

The Transition Pathway Initiative (TPI) assessment (see section 5.3 for details) examines corporate target setting and highlights a forward-looking aspect of the PAB and CTB requirements; by rewarding companies with appropriate policies to reduce their carbon footprint and manage future carbon risks. We, therefore, also require the PAB and CTB indexes to demonstrate improvements in both TPI Management Quality and Carbon Performance.

In order to ensure the PAB and CTB indexes remain a practical solution, we incorporate additional investment capacity and diversification requirements:

Table 2: FTSE PAB and CTB Index Objectives: Additional Requirements

FTSE PAB and CTB Index: Additional Requirements	
Investment Capacity	Company weight less than 20x benchmark weight
Concentration	Index Effective N ⁵ at least 25% of benchmark

The spirit of the TEG report is that PAB and CTB benchmarks should shift allocations from carbon intensive assets towards companies developing solutions necessary for the transition to a low carbon world. To avoid the over representation of sectors with a marginal impact on climate, a constraint requiring the aggregate weight of highly exposed sectors to be in line with that of the benchmark index is imposed. The highly exposed sectors are defined in Annex I of Regulation (EC) No 1893/2006. We list the equivalent highly exposed ICB sub-sectors in Table A in Appendix I and impose the aggregate weight constraint to these sub-sectors.

As detailed in Table 1, the PAB requirements involve a more demanding carbon emission target and a more extensive set of exclusions compared to the CTB that make the highly exposed sector constraint more difficult to achieve. In the remainder of this paper, we focus on the FTSE All-World PAB Index that applies the PAB requirements to the FTSE All-World Index. The framework examined here is equally applicable to achieve the less onerous CTB requirements.

5 Effective N is defined as the reciprocal of the sum of the squared stock weights of a portfolio: $1/\sum_i w_i^2$

4. Target Exposure Framework

The FTSE Russell tilt approach provides a transparent mechanism for exercising control over multiple portfolio exposure objectives. The tilt approach can be extended to target a variety of exposure types, including Sustainable Investment exposures, spanning Carbon and ESG objectives, in addition to country and industry weight objectives. The framework utilizes a general tilt equation, where each stock index weight results from multiplying the benchmark weight by a series of tilts. Each tilt consists of set stock level scores corresponding to each design objective e.g. Operational Carbon Emissions. In general, stock weights in the target exposure framework take the following form:

$$\text{Index Weight} = \text{Benchmark Weight} \times \underbrace{S_{Val}^n \times \dots \times S_{Mom}^p}_{\text{Factor}} \times \underbrace{S_{CO2}^q \times \dots \times S_{ESG}^r}_{\text{SI}} \times \underbrace{S_{Beta}^s}_{\text{Beta}} \times \underbrace{C \times I}_{\text{Country \& Industry}} \quad (1)$$

4.1 Target Exposure: Incorporating PAB Requirements

The PAB objectives require a set of quantitative company assessments or scores. Companies are scored based on each of these assessments and reweighted using the tilt approach described above to achieve the specific set of index objectives.

Table 3: Quantitative Company Scores

Company Assessments	Definition
Carbon Emission Intensity	S_{EM} : Carbon Emission Intensity z-score as defined in the FTSE Global Climate Index Series ⁶
Carbon Reserves – Potential Emission Intensity	S_{FF} : Fossil Fuel Reserve z-score as defined in the FTSE Climate Index Series
Green Revenue	S_{GR} : Green Revenue Score as defined in FTSE Green Revenues Index ⁷ Series
Corporate Target Setting	S_{TPI} : TPI Management Quality score as defined in FTSE TPI Climate Transition Index Series ⁸
	S_{CP} : TPI Carbon Performance score as defined in FTSE TPI Climate Transition Index Series

For each company, its weight in the FTSE All-World PAB Index is:

$$\text{PAB Index Weight} = \text{Benchmark Weight} \times S_{EM}^a \times S_{FF}^b \times S_{GR}^c \times S_{TPI}^d \times S_{CP} \times C \quad (2)$$

where the exponents a, b, c and d are tilt powers determined at each index rebalance to achieve the design objectives. C is an additional set of tilt parameters that ensures the resulting index satisfies the highly exposed sector, capacity and concentration constraints. In what follows, the FTSE All-World PAB Index is rebalanced annually in September.

⁶ For Details on FTSE Climate Index Series, see: <https://www.ftserussell.com/products/indices/global-climate>

⁷ For Details on FTSE Green Revenues Index Series, see: <https://research.ftserussell.com/products/indices/green-revenues>

⁸ For Details on FTSE TPI Index Series, see: <https://www.ftserussell.com/index/spotlight/ftse-tpi-climate-transition-index>

5. Achieving PAB Objectives

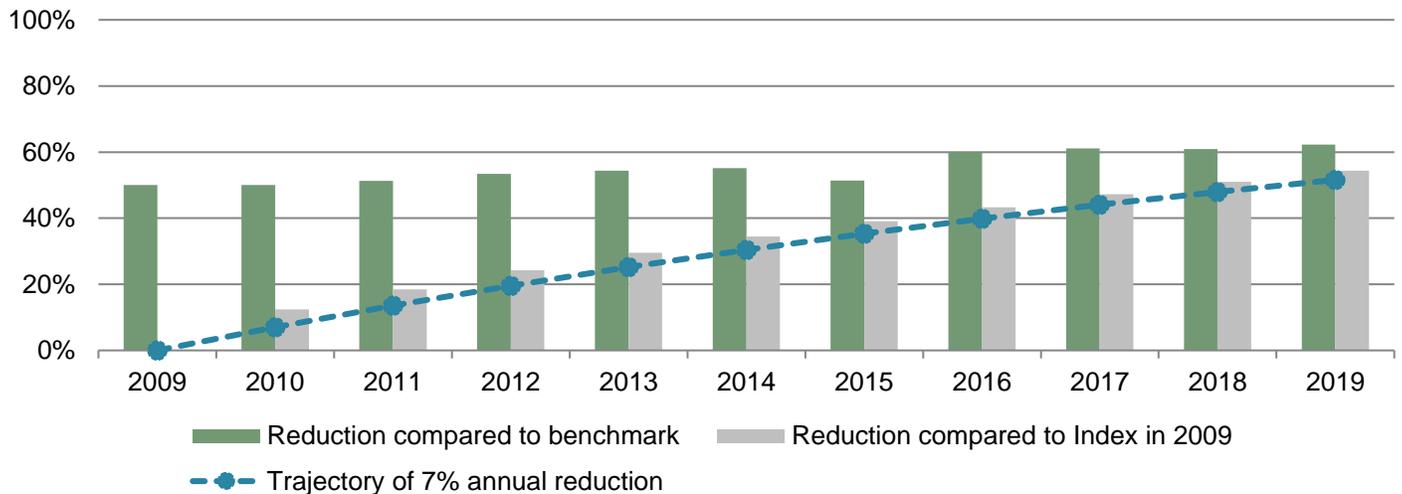
A key feature of the FTSE Target Exposure framework is the ability to consistently target specific index exposure objectives. The PAB’s objectives include improvements in carbon emission intensity, green revenue outcomes and corporate target setting. The FTSE All-World PAB Index meets all of these objectives at each annual September rebalance over the simulation period. In the following sub-sections, we discuss in more detail each of these outcomes.

5.1 Carbon Emissions

The PAB emission goals encompass both reductions in operational carbon emissions and in potential carbon emissions in terms of possible and probable fossil fuel reserves. Operational carbon emissions are defined as the latest annual operational carbon emissions of CO₂ equivalent greenhouse gas (GHG) emissions in metric tons scaled by enterprise value (including cash). Fossil fuel reserves are defined as the estimated CO₂ equivalent GHG emissions in metric tons through the use and combustion of recoverable coal and oil and gas reserves, scaled by full market capitalization (in USD). The phased incorporation of Scope 3 emissions⁹ is an additional objective of the TEG report. The measure of operational emissions used here, encompasses Scope 1 and 2 emissions. The carbon or fossil fuel reserves metric is employed as a measure of Scope 3 emissions for coal, oil and gas companies. The benchmark construction framework we employ is sufficiently flexible to enable PAB and CTB indexes to incorporate alternative Scope 3 emission definitions in the future.

The FTSE All-World PAB Index achieves a greater than 50% reduction in both operational and potential carbon emissions relative to the FTSE All-World Index. This is illustrated by the green bars in Figures 1 and 2 respectively. In addition, the FTSE All-World PAB Index achieves a 7% year-on-year improvement in both operational and potential emissions. This 7% annual reduction ensures the goal of reducing emissions by 50% at the end of the ten-year period is achieved. In figures 1 and 2, the target trajectory is represented by the dashed blue line and the corresponding reductions of the PAB index with the grey bars. By attaining the 7% annual reduction in emissions each year, the FTSE All-World PAB Index therefore also meets the goal of a 50% reduction in both operational and potential emissions over the 10-year timeframe.

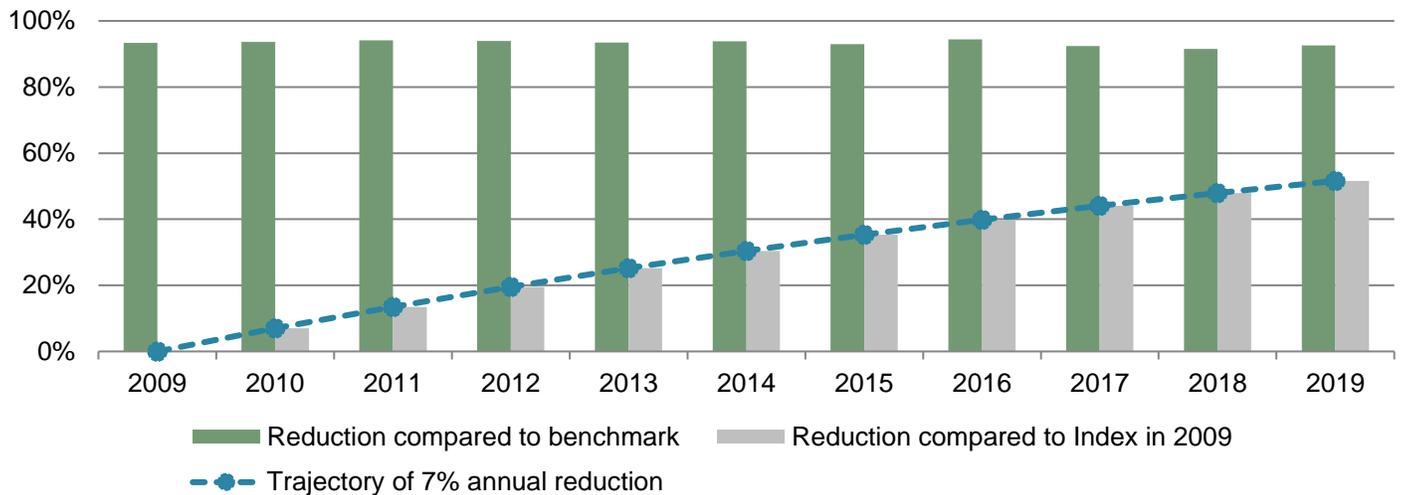
Figure 1: The FTSE All-World PAB Index: Operational Carbon Emissions Reduction



Source: FTSE Russell. Emission data sourced from Trucost, data as of May 2020. Performance shown for the FTSE All-World PAB Index is hypothetical and for illustrative purposes only. Past performance is no guarantee of future results. Please see the end for important legal disclosures.

⁹ For details of the scopes of emissions, see <https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf>

Figure 2: FTSE All-World PAB Index: Potential Carbon Emissions Reduction – Fossil Fuel Reserves



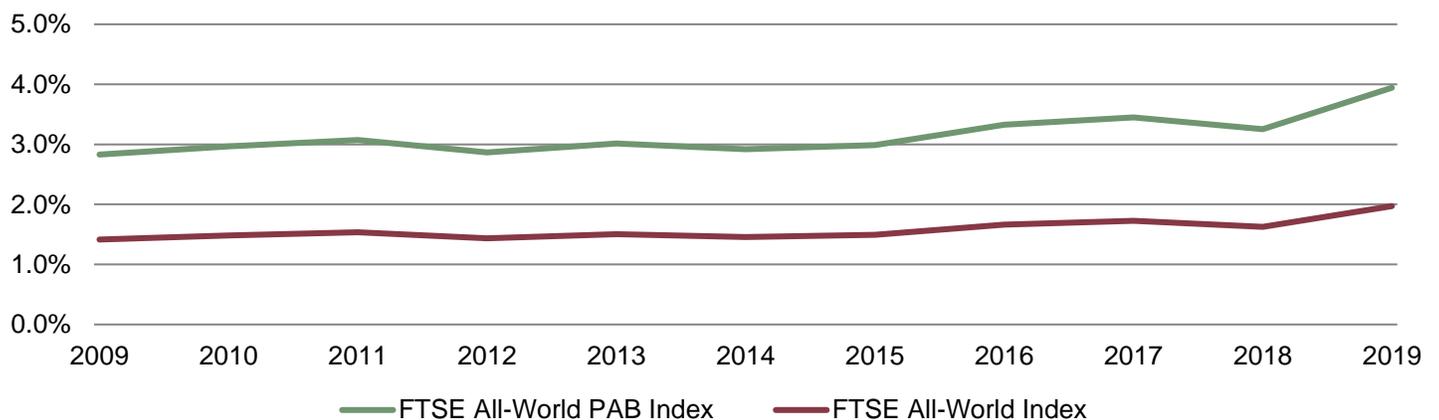
Source: FTSE Russell. Reserve data sourced from Trucost, data as of May 2020. Performance shown for the FTSE All-World PAB Index is hypothetical and for illustrative purposes only. Past performance is no guarantee of future results. Please see the end for important legal disclosures.

5.2 Green Revenue

The FTSE Russell Green Revenues data model¹⁰ categorizes a company’s revenue using an industrial taxonomy for green goods, products and services into 10 sectors and 64 sub-sectors. This permits the percentage of total revenue arising from green products for a company to be identified.

While the latest draft EU BMR regulation no longer includes a requirement to improve the proportion of green to brown revenues, earlier drafts of the TEG report did include such a provision. For this reason and those outlined earlier, we continue to include a requirement that the benchmark demonstrates a significant increase in the green to brown revenue ratio. This is readily achieved as a byproduct of the reduction in fossil fuel reserves resulting from the activity-based exclusions. However, the introduction of an intentional green revenue objective ensures the FTSE All-World PAB Index not only improves the ratio of green to brown revenues, but doubles the absolute level of green revenues relative to the benchmark.

Figure 3: FTSE All-World PAB Index: Proportion of Green Revenue (%)



Source: FTSE Russell, based on data from September 2009 to December 2019. Performance shown for the FTSE All-World PAB Index is hypothetical and for illustrative purposes only. Past performance is no guarantee of future results. Please see the end for important legal disclosures.

¹⁰ For details, see <https://www.ftserussell.com/data/sustainability-and-esg-data/green-revenues-data-model>.

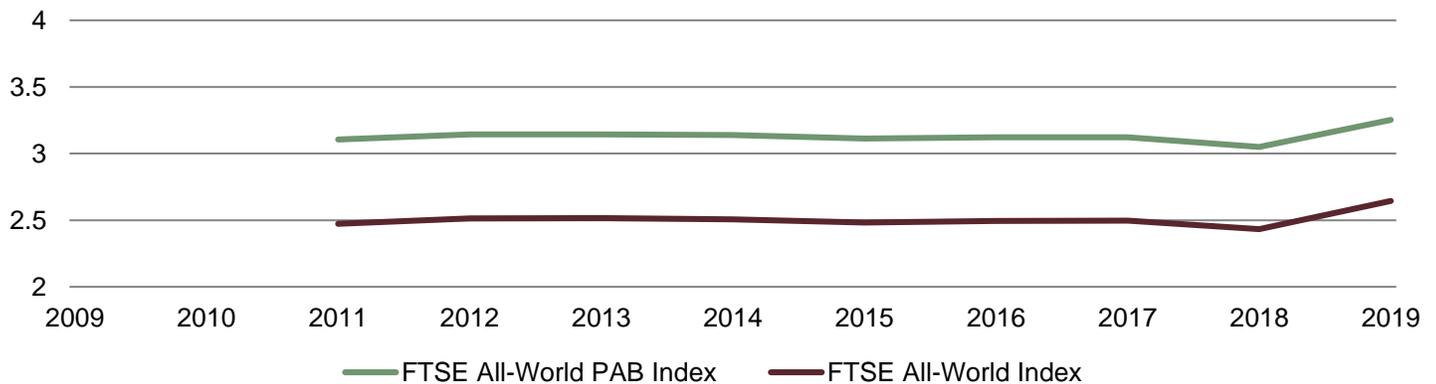
5.3 Corporate Target Setting and Forward-Looking Assessments of Climate Trajectories

The Transition Pathway Initiative (TPI) was set up by asset owners to provide a consistent framework of measures to analyze the world's largest and most carbon intensive public companies' climate transition strategies. It is based on the TCFD¹¹ recommended measures and provides a basis for investors to collaboratively engage companies alongside other investors.

The TPI provides an assessment of (i) how well a company manages climate risks and opportunities (TPI Management Quality score) and (ii) a quantitative analysis of how the planned and expected carbon performance of each company compares to trajectories required to achieve targets of restricting global average temperature increases to below a rise of two degrees (TPI Carbon Performance).

The FTSE All-World PAB Index¹² demonstrates a consistently higher TPI Management Quality Score than the benchmark FTSE All-World Index over the ten-year simulation period¹³.

Figure 4: FTSE All-World PAB Index: TPI Management Quality Score



Source: FTSE Russell, based on data from September 2009 to December 2019. Performance shown for the FTSE All-World PAB Index is hypothetical and for illustrative purposes only. Past performance is no guarantee of future results. Please see the end for important legal disclosures.

11 The Financial Stability Boards Taskforce on Climate-related Financial Disclosure.

12 The target increase in TPI Management Quality score at each annual index rebalance is set at 50% of the cross-sectional standard deviation of the FTSE All-World universe TPI Management Quality scores.

13 TPI data available from 2011 onwards.

6. Active Industry and Country Weights

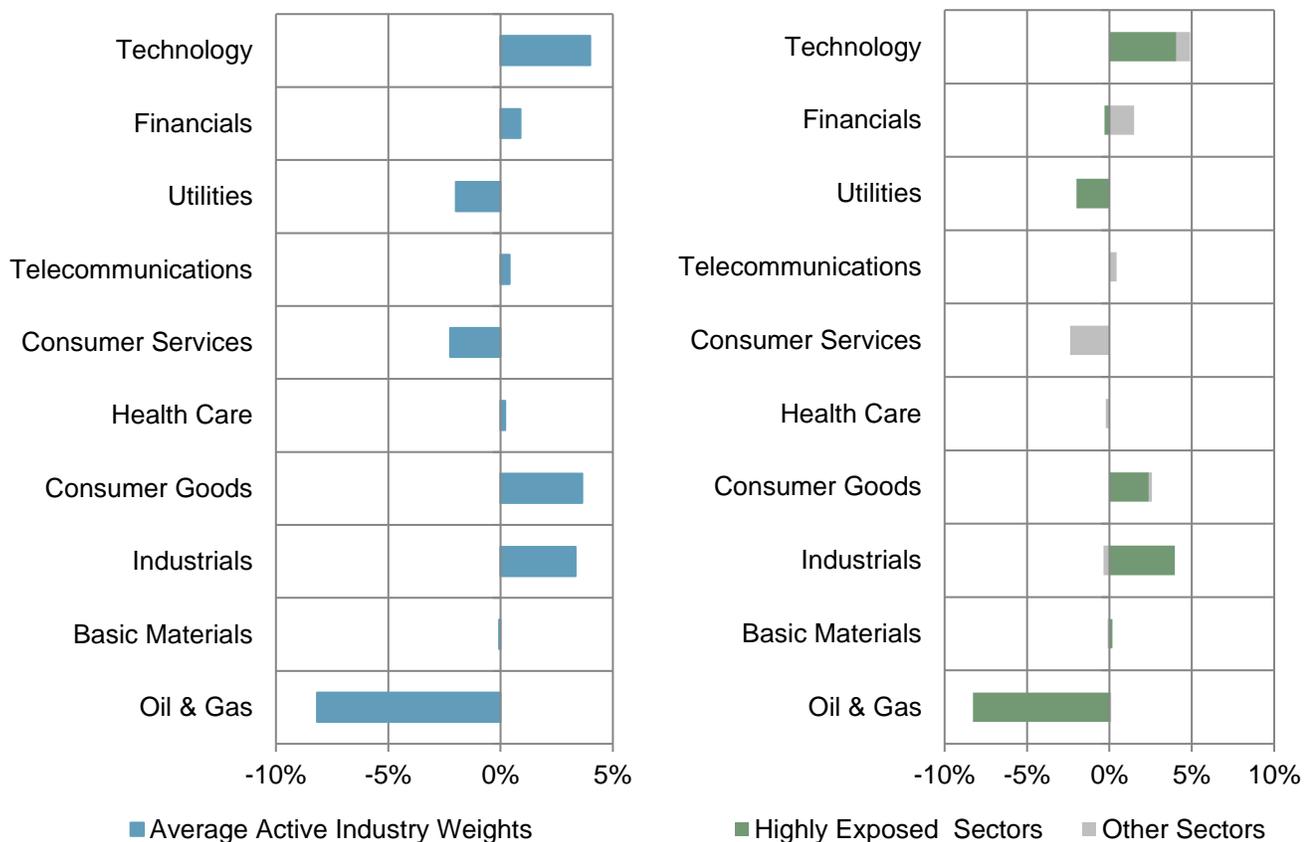
The FTSE All-World PAB Index is constructed using a series of tilts to achieve each the PAB objectives. Tilting reweights companies in accordance with their score on each of the design metrics. In the absence of constraints, this will result in active industry and country weights that reflect industry and country exposures to each design metric.

6.1 Active Industry Weights

The TEG report identifies a set of highly exposed sectors (See Table A in Appendix I for the equivalent ICB sub-sectors); the weights of these highly exposed sectors in aggregate should reflect those of the benchmark index. This is arguably the most demanding constraint contained in the PAB requirements. We, therefore, constrain the aggregate weight of the relevant high impact ICB sub-sectors in the FTSE All-World PAB Index to mirror those of the FTSE All-World Index.

The activity-based exclusions also directly affect the weighting of highly exposed sectors. Consequently, the FTSE All-World PAB Index underweights ICB industries such as Oil & Gas and Utilities. However, the interplay of these two requirements results in compensating overweight positions in Consumer Goods and Industrials, which have relatively lower levels of carbon emissions compared to other highly exposed sectors. We illustrate this at the ICB industry level in the left-hand chart in Figure 4. The chart on the right-hand side of figure 4 distinguishes the contribution of highly exposed and non-highly exposed sectors to active industry weights. This is illustrated by the green and gray bars respectively, where the aggregate weight of the green bars sums to zero in order to achieve the neutrality requirement for the highly exposed sectors.

Figure 5: FTSE All-World PAB Index: Average Active Industry Weights



Source: FTSE Russell, based on data from September 2009 to December 2019. Weights shown for the FTSE All-World PAB Index is hypothetical and for illustrative purposes only. Past performance is no guarantee of future results. Please see the end for important legal disclosures.

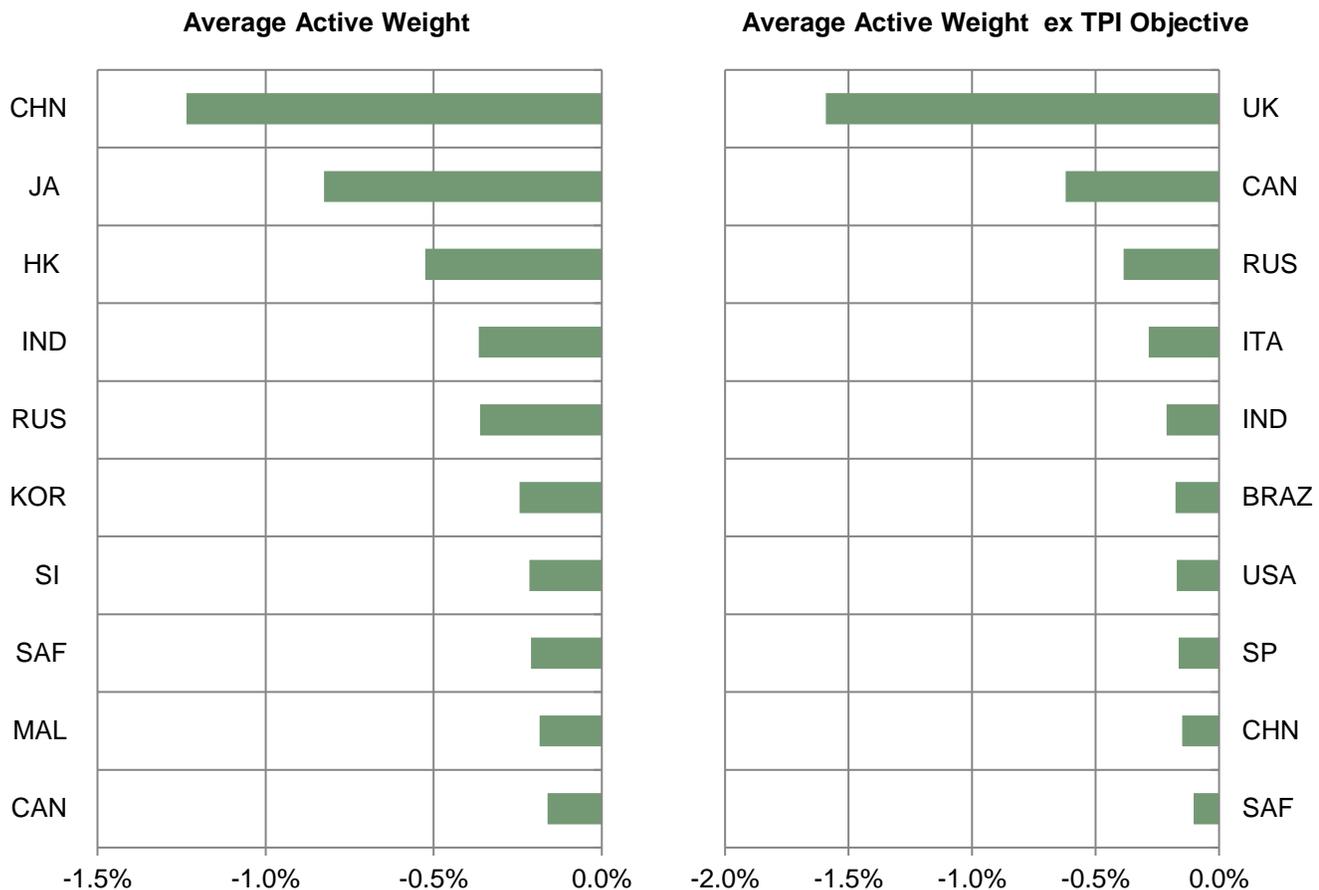
In general, active industry weights are determined by the carbon emission and activity-based exclusion objectives, subject to the constraint imposed on the active weights of the high impact sectors.

6.2 Active Country Weights

The active country weight profile of the FTSE All-World PAB Index exhibits greater variation resulting from the combined effects of exclusions, emission tilts and the TPI objective. The right-hand panels of figures 5 and 6 present the average active country weights, in the absence of any TPI objective, to illustrate the effect such an objective has on active country weights.

Countries that are highly exposed to natural resources such as, Canada and Russia, are underweighted through a combination of fossil-fuel related company exclusions and the (low) emission tilt (see figure 5). Conversely, countries such as Switzerland are overweighted, through a combination of relatively high TPI scores and low exposure to carbon emissions (see figure 6). In contrast, China is additionally negatively affected by relatively poor TPI measures, resulting in an average underweight position of approximately 1.2%.

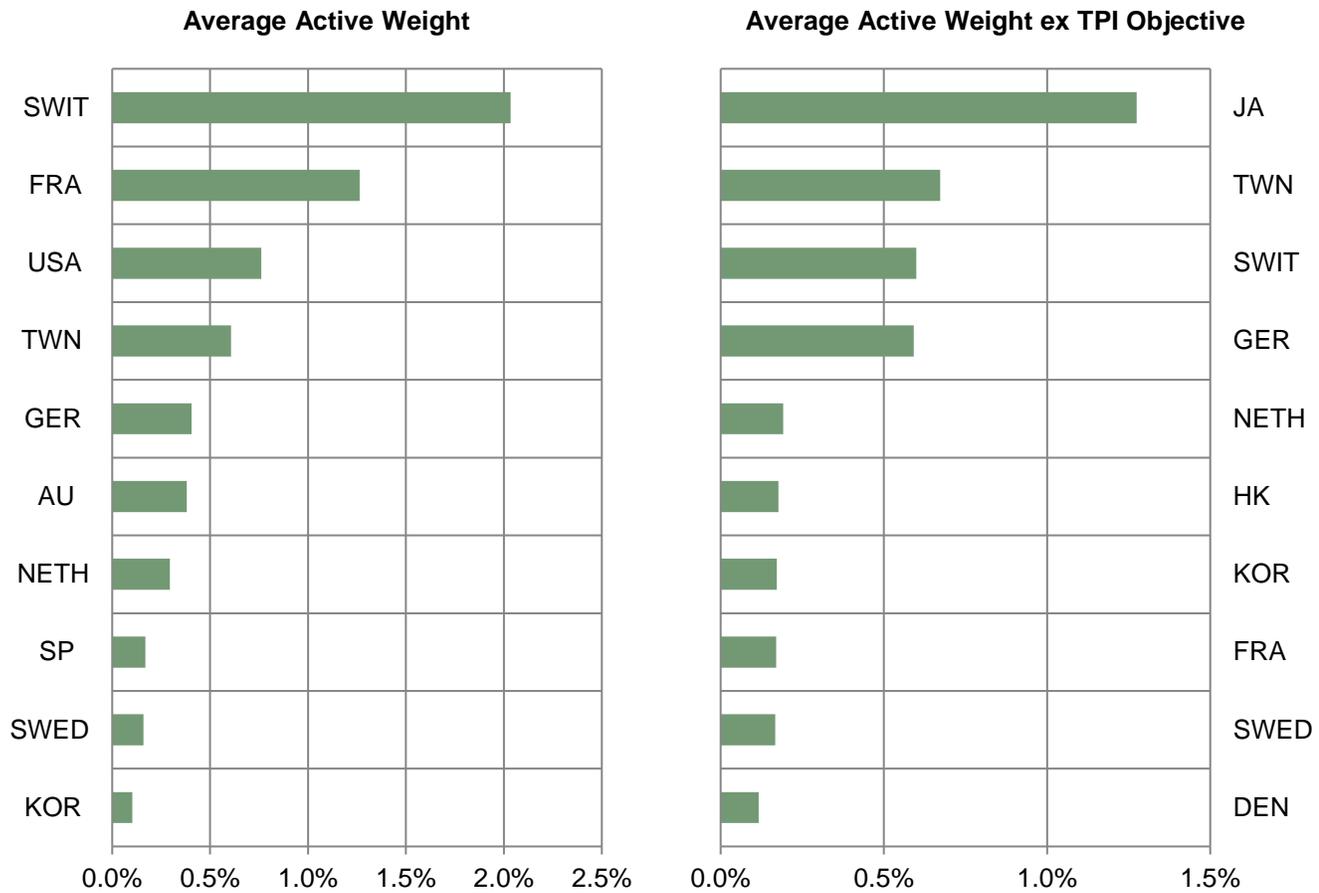
Figure 6: FTSE All-World PAB Index: Bottom-10 Average Active Country Weights



Source: FTSE Russell, based on data from September 2019 to December 2019. Weights shown for the FTSE All-World PAB Index is hypothetical and for illustrative purposes only. Past performance is no guarantee of future results. Please see the end for important legal disclosures.

Japan is a particularly interesting case; Japan has little exposure to natural resources and relatively low levels of emissions. In the absence of TPI objectives Japan would be the most overweight country. However, it has relatively poor TPI performance resulting in one of the largest underweight country positions in the FTSE All-World PAB Index. This indicates that a given improvement in aggregate TPI outcomes is more difficult to achieve compared to other objectives and requires a more rigorous reweighting. We demonstrate this by removing the TPI objectives from the FTSE All-World PAB Index and observing the effect on Japan's active country weight. This is illustrated in Figure 6, where Japan now moves to the largest overweight country position.

Figure 7: FTSE All-World PAB Index: Top 10 Average Active Country Weights



Source: FTSE Russell, based on data from September 2019 to December 2020. Weights shown for the FTSE All-World PAB Index is hypothetical and for illustrative purposes only. Past performance is no guarantee of future results. Please see the end for important legal disclosures. AU=Australia, SP=Spain; TWN=Taiwan; JA=Japan.

This also highlights the case of the UK. The UK is highly exposed to fossil fuels, but also has above average TPI scores. Overall, this results in the UK remaining relatively close on average to the benchmark weight. In the absence of TPI adjustments, the UK would be the most underweight country.

The US has significant exposure to Oil & Gas, but also large off-setting exposures to low emission sectors such as Technology and Financials. These effects work largely in opposite directions; on average cancelling one another at the country level. This results in small active country weights for the US, in the absence of TPI targets, such that it no longer appears in the list of top and bottom active country weights. The application of TPI targets, however, results in the US becoming one of the largest overweight countries in FTSE All-World PAB Index because of its exposure to companies with relatively high TPI scores.

7. FTSE All-World PAB Index Performance

FTSE All-World PAB Index demonstrates a consistent positive excess return compared to the benchmark FTSE All-World Index over the ten-year simulation period. It displays similar levels of volatility, but a smaller maximum drawdown.

Turnover is on average 17% p.a., with an annualized tracking error of 1.2% and practical levels of investment capacity¹⁴ and diversification. The FTSE All-World PAB Index exhibits investment capacity and diversification levels of approximately 63% (1/1.58) and 56% (250/448) respectively of the benchmark.

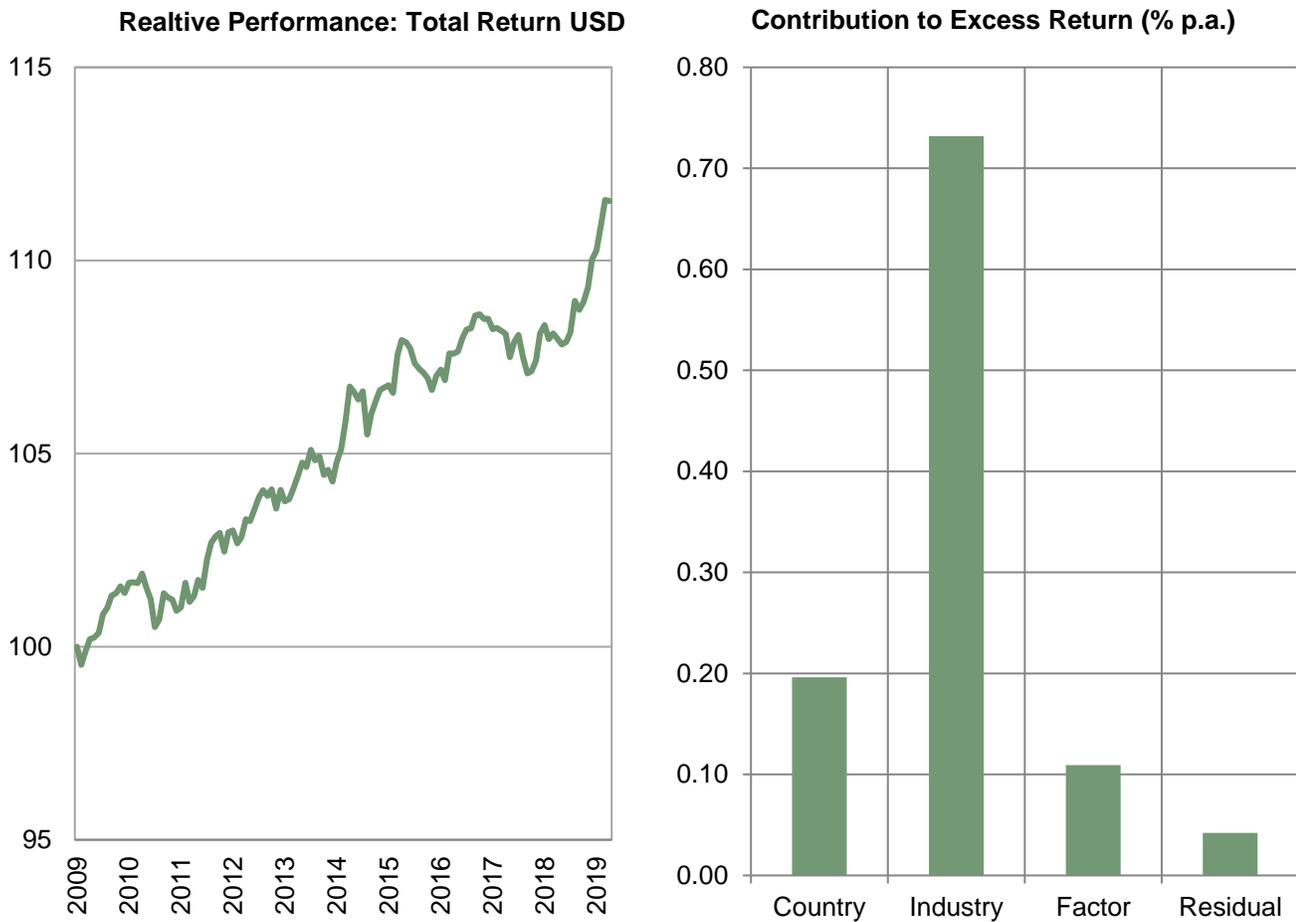
Table 4: FTSE All-World PAB Index: Performance Summary

Description	FTSE All-World Index	FTSE All-World PAB Index
Geometric Return % p.a.	9.45	10.63
Volatility % p.a.	13.63	13.67
Return/Risk Ratio	0.69	0.78
Max Drawdown %	-16.25	-15.5
Turnover % p.a.	9.8	17.02
Excess Return % p.a.	–	1.08
Vol. Reduction % p.a.	–	-0.29
Information Ratio	–	0.9
Tracking Error % p.a.	–	1.2
Capacity Ratio	1	1.58
Effective N	448	250

Source: FTSE Russell, data based on USD total return from September 2009 to December 2019. Performance shown for the FTSE All-World PAB Index is hypothetical and for illustrative purposes only. Past performance is no guarantee of future results. Please see the end for important legal disclosures.

¹⁴ Capacity Ratio: Index Capacity Ratio = Sum of [Stock PAB Index Weight × (Stock PAB Index Weight / Stock Benchmark Weight)].

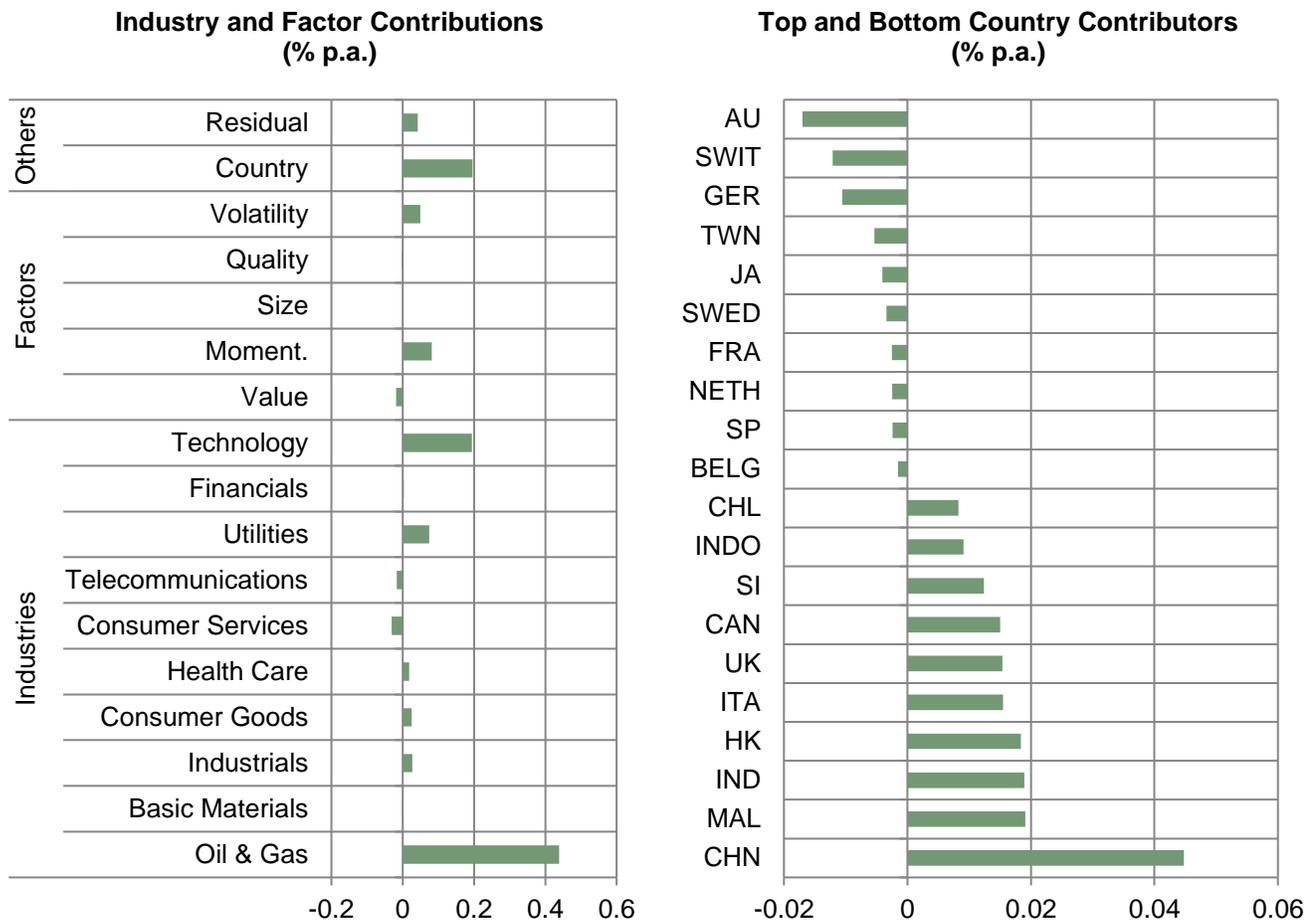
Figure 8: FTSE All-World PAB Index: Relative Performance and Performance Attribution



Source: FTSE Russell, data based from September 2009 to December 2019. Data as at May 2020. Performance shown for the FTSE All-World PAB Index is hypothetical and for illustrative purposes only. Past performance is no guarantee of future results. Please see the end for important legal disclosures.

Attribution of the excess return of the FTSE All-World PAB Index relative to the FTSE All-World Index indicates that the observed outperformance arises primarily from industry effects. The FTSE All-World PAB Index industry profile is a significantly underweight Oil and Gas. This is the main source of the industry excess return contribution. Figure 8 below provides a more detailed breakdown of the industry and factor contribution to performance.

Figure 9: FTSE All-World PAB Index: Detailed Performance Attribution



Source: FTSE Russell, data based from September 2009 to December 2019. Performance shown for the FTSE All-World PAB Index is hypothetical and for illustrative purposes only. Past performance is no guarantee of future results. Please see the end for important legal disclosures.

Oil and Gas (underweight) is by far the largest contributor to excess return, accounting for nearly half of the total excess return, with Technology also making a notable contribution as a result of an uplift in weight arising from the low emission tilt. The largest country contributors, such as China (positive) and Switzerland (negative) result from active weights, where the TPI objective has exerted a large influence on country weights as discussed in section 5.

8. Conclusions

The Paris-aligned benchmark (PAB) is a progressive climate transition benchmark specified in the EU Technical Expert Group Report on Climate Transition and Paris aligned Benchmarks. It requires that a benchmark wishing to be classified as Paris-aligned meet a comprehensive set of objectives beyond simple reductions in carbon emissions.

The FTSE Target Exposure framework is a flexible structure that permits the construction of portfolios with precise exposure objectives to style factors, climate targets and ESG objectives. This paper employs the Target Exposure framework to construct a Paris-aligned benchmark based on the FTSE All-World universe.

We demonstrate that over the simulation period from 2009 to 2019, the resulting FTSE All-World PAB Index is able to achieve all the required objectives specified in the TEG report and examine the sources of outperformance over the period. We incorporate additional constraints to ensure the resulting index is replicable and employ the Target Exposure framework to assess the effect of the individual requirements on index outcomes.

The Target Exposure framework that underpins our construction approach ensures the FTSE All-World PAB Index consistently achieves all the PAB climate transition objectives. This approach may be readily used to create Paris-aligned regional benchmarks, Climate Transition Benchmarks (CTB) and to incorporate additional bespoke objectives such as, more aggressive climate transition outcomes and specific ESG targets.

9. Appendix I Highly Exposed ICB Sub-sectors

Table A: Highly Exposed FTSE Russell ICB Sub-sectors

ICB Sub-sectors: Highly Exposed	
Commodity Chemicals	Building Materials & Fixtures
Specialty Chemicals	Heavy Construction
Forestry	Aerospace
Paper	Defence
Aluminium	Containers & Packaging
Nonferrous Metals	Diversified Industrials
Iron & Steel	Electrical Components & Equipment
Coal	Electronic Equipment
General Mining	Commercial Vehicles & Trucks
Conventional Electricity	Industrial Machinery
Alternative Electricity	Delivery Services
Gas Distribution	Marine Transportation
Multiutilities	Railroads
Water	Trucking
Exploration & Production	Business Support Services
Integrated Oil & Gas	Real Estate Holding & Development
Oil Equipment & Services	Real Estate Services
Pipelines	Industrial & Office REITs
Automobiles	Retail REITs
Auto Parts	Residential REITs
Tires	Diversified REITs
Brewers	Specialty REITs
Distillers & Vintners	Hotel & Lodging REITs
Soft Drinks	Computer Hardware
Farming Fishing & Plantations	Electronic Office Equipment
Food Products	Semiconductors
Clothing & Accessories	Specialized Consumer Services
Tobacco	

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