MSCI IndexMetrics®

An Analytical Framework for Factor, ESG and Thematic Investing

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June 2020

Contents

This report may contain analysis of historical data, which may include hypothetical, backtested or simulated performance results. There are frequently material differences between backtested or simulated performance results and actual results subsequently achieved by any investment strategy

The analysis and observations in this report are limited solely to the period of the relevant historical data, backtest or simulation. Past performance — whether actual, backtested or simulated — is no indication or guarantee of future performance. None of the information or analysis herein is intended to constitute investment advice or a recommendation to make (or refrain from making) any kind of investment decision or asset allocation and should not be relied on as such.

Introduction

Index investing has seen tremendous growth. Strategies that were once only available to a select number of institutional investors using sophisticated financial products, are now accessible even to the retail public in a cost-effective manner. Once created to serve as a "benchmark" tool for the asset owner community and to increase the transparency and integrity of financial markets, its usage has significantly expanded over time.

Much of the growth stems from the wide adoption of factor investing. We previously discussed the rationale for factor investing and how indexes can be constructed to reflect factor returns in cost-effective and transparent ways (Bender 2013). From the institutional perspective, factors have been deeply embedded in the investment process. As of the end of February 2020, there were over 1,300 factor equity ETFs/ETPs with approximately total assets of USD 800 billion (ETFGI 2020).

More recently, a growing number of investors have sought to integrate environmental, social and governance (ESG) and climate change considerations into their portfolios. We observed five key motivations driving this adoption:

1. Addressing values-based investment constraints, such as divesting from armament or tobacco-related securities.
2. Mitigating long-term systemic risks such as carbon risks and climate opportunities: Universal owners, in particular, may be concerned about potential spillover effects from their direct investments that may generate costs for unrelated third parties. These costs ultimately may be borne by the entire economy and affect future returns.
3. Reducing systematic risks caused by changes in the market environment and the economy.
4. Identifying stock-specific opportunities and risks in portfolios.
5. Investing with impact (e.g., to drive positive social or environmental change).

There are many ways of incorporating factors, ESG and thematic criteria in the investment process while considering practical implementations. These include the level of the desired exposure to a given investment strategy, tracking error, turnover and capacity. These considerations may lead to different implementations to capture exposure to the same investment theme. Multi-factor strategies that aim to provide exposure to several factors, as well as indexes targeting both factor exposures and ESG characteristics, have also become increasingly popular over the past years (Bender 2013). This development has led to the creation of a relatively large number

of indexes and a need for measuring, evaluating and comparing those indexes in a consistent way.

Thus, to address this need, MSCI introduced the IndexMetrics® framework in 2013 as a lingua franca for evaluating and monitoring factor indexes along several dimensions, including performance, exposure and investability.

IndexMetrics has served our clients well over the past seven years and has become a standard framework both internally within MSCI for new index development and externally to help investors evaluate, compare and monitor indexes both before and after factor strategy implementation.

Originally built as a tool to analyze factor indexes, its uses have expanded over time to cover other index types such as ESG and thematic investing. As markets and investment processes continued to evolve, we remain committed to enhancing the IndexMetrics framework and keeping it relevant. Major updates included the addition of performance attribution using MSCI's Barra equity risk models and reporting index style factor exposures using MSCI FaCS™ (Bonne 2018). As many long-term investors increasingly incorporated ESG and climate change considerations into their portfolios (Melas 2016), we enhanced the framework by adding ESG and Carbon metrics.

This paper provides a comprehensive overview of the IndexMetrics analytical framework. It is an update to the "Introducing MSCI IndexMetrics" launch paper (Kassam 2013). We first introduce factor investing and the goal of the framework. We then define the scope and describe the output of IndexMetrics by analyzing the flagship factor and ESG indexes based on the MSCI ACWI Index universe through the lens of the framework.

What Is MSCI IndexMetrics?

The Aim of IndexMetrics

IndexMetrics is designed to provide institutional investors with quantitative measures along four dimensions — key metrics, performance, exposure and investability — that can inform their decisions regarding factor investments, including multi-factor allocations. It also provides insight into the ESG and Climate change characteristics of the index and how these compare with the benchmark. IndexMetrics leverages MSCI's extensive and high-quality historical data while using the Barra analytical framework to generate factor exposure and performance attribution insights. The metrics it provides collectively give a comprehensive view of the performance, exposure and investability characteristics of an index. Moreover, regarding a multi-factor index, it grants insight into the diversification effects.

IndexMetrics — Scope and Output

The motivation for IndexMetrics comes from our many investors who asked for scalable, standardized analytical tools to help them address the following questions when choosing between different single- and multi-factor investment strategies:

- Performance
    - How has the factor index performed in absolute, relative and risk-adjusted terms?
    - What is the profile of the factor index return distribution?
    - What factor exposures have driven active returns, and which factors contributed the most to them?
- Exposure
    - What are the active index factor, sector, region and size exposures relative to its benchmark?
    - How does the index look now and relative to history in terms of financial ratios?
    - What are the ESG characteristics of the index, its attributes and MSCI ESG Ratings scores, as compared to its benchmark? What are its climate change exposures, and are those higher or lower than those of the benchmark?

- Investability
    - How liquid, on average, are the index constituents?
    - What is the capacity of the index? Given a hypothetical portfolio size and daily trading limit assumptions, how long does it take to implement changes due to an index review?
    - What turnover should an institutional investor expect when replicating the index?

A summary and measure groupings of the framework are given in Exhibit 1. Note that when we mention "active" risk, return or factor exposures, these regard the parent index. The rest of this paper highlights the sample metrics through an example IndexMetrics report on six high-exposure factor indexes based on the MSCI ACWI Index. We also include the MSCI ACWI Diversified Multi-Factor Index that represents a multi-factor strategy targeting higher exposure to four style factors: value, momentum, low size and quality. Moreover, we consider the MSCI ACWI ESG Leaders, MSCI ACWI Low Carbon Target and MSCI ACWI Climate Change Indexes for their ESG characteristics. A detailed definition of the metrics and their calculation methodology are given in the Appendix. Risk measures come from the MSCI Global Total Market Equity Model for Long Term Investors (GEMLT).

Exhibit 1: Summary and Measure Grouping of the MSCI IndexMetrics Framework

Key Metrics	
Key metrics	• Return (Total, Active) • Risk (Total, Active) • Return/Risk • Sharpe/Information ratio • Historical beta • Average number of constituents • Turnover • Key valuation ratios • YTD, and 1-, 3-, 5- and 10-yr Returns

Exposure Metrics	
Active exposures	• MSCI Factor Box • Active FaCS, factor, sector, region, country and size family exposures
Financial ratios	• Price-to-book • Price-to-cash-earnings • Price-to-earnings • Dividend yield • Long-term forward EPS growth rate • Sustainable growth rate • Return on equity • Debt to equity
ESG integration, values and norms	Integration: • MSCI ESG Ratings score • ESG leaders • ESG laggards • ESG trend positive • ESG trend negative • Index ESG rating • Environmental pillar score • Social pillar score • Governance pillar score Key governance metrics: • Board independence • Female directors • Deviation from one share, one vote Values and norms: • Tobacco involvement • Civilian firearms producers • Ties to controversial weapons • Global compact compliance violation • Red-flag controversies • Orange-flag controversies

Climate change	Climate footprint: • Carbon emissions • Carbon intensity • Weighted-average carbon intensity Low carbon transition risks: • Low carbon transition score • Solutions • Product and operational transition • Asset stranding Exposure to asset stranding risks: • Potential carbon emissions • Fossil fuel reserves • Thermal coal mining • Thermal coal-based power generation • Unconventional oil and gas extraction Exposure to clean technology solutions: • Clean technology solutions • Clean technology solutions revenue • Green/brown net revenue exposure Other climate metrics: • Exposure to carbon-related assets • Climate-related controversies • Low carbon transition management score
Performance Metrics	
Performance attribution	• Calendar-year returns • Performance attribution tree using MSCI's Barra equity risk models • Top contributions and exposures (styles, industries, countries) • Top recent security-level contributions

Risk profile	• Risk (total, active, downside) • Sortino ratio • 95/99 percentile VaR • Expected shortfall (CVar) @ 95/99% • Maximum drawdown (total, active) • Maximum drawdown period in months (total, active) • Skewness and kurtosis • Tracking error
Investability Metrics	
Capacity and concentration	• Average/effective number of constituents • Parent-index coverage • Top 10 security weight • Size family exposures (large/mid/small/micro) • Capacity measures (% of float/full market cap) • Active share • Average/maximum weight multiplier • Maximum strategy weight • Lorenz curves
Liquidity and cost of replication	• Weighted average ATVR • Days to trade — periodic rebalancing and relative to parent index/cash • Turnover • Performance drag
Top constituents and top active positions	• Top Absolute/Active Weights

Key Metrics

The key metrics, along with charts and tables of absolute and relative index performances, are intended to provide a high-level one-page summary of the characteristics and performance of the factor index relative to its benchmark and provide stepping off points for the more detailed analysis in later sections. The key metrics, along with their definitions, are detailed in Exhibit 2.

Exhibit 2: Key Metrics

Metric	Definition
Total return	Index return, annualized if the analysis period is greater than one year
Total risk	Annualized total risk computed as the standard deviation of monthly index returns
Return/risk	Total return to total risk ratio expressing the index return per unit of total risk
Sharpe ratio	Ratio of index excess return over the risk-free rate and annualized total risk
Active return	Difference between the index and benchmark return
Tracking error	Annualized standard deviation of monthly active returns measuring the dispersion of index excess returns relative to its benchmark
Information ratio	Ratio of active return and tracking error measuring how well the index return above the benchmark compensates for the deviation from that benchmark
Historical beta	The level of sensitivity of the index to its benchmark
Number of constituents	Average number of index constituents in the analysis period
Turnover	The percentage change in the composition of an index at each index review
Price-to-book	Weighted harmonic mean of constituent price-to-book ratios
Price-to-earnings	Weighted harmonic mean of constituent price-to-earnings ratios
Dividend yield	Weighted mean of constituent dividend yields

Exhibits 3 and 4 illustrate and summarize the 20-year historical performance of the six high exposure factor indexes and the diversified multi-factor index based on the MSCI ACWI Index relative to their parent index. Notably, all seven indexes

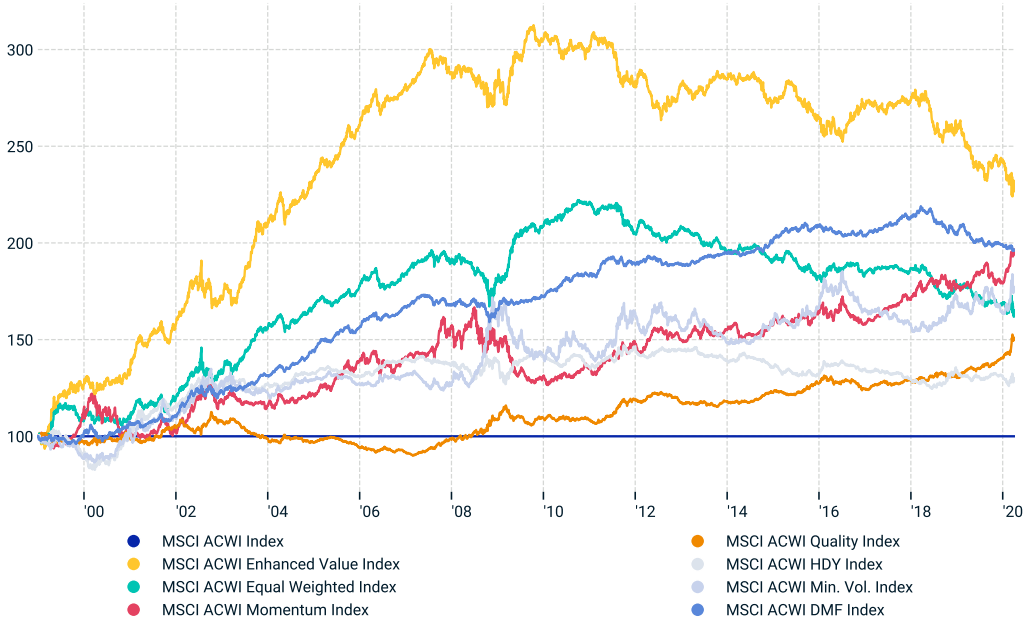
outperformed the market benchmark throughout the analysis period, and the table further shows that they outperformed on a risk-adjusted basis, thus leading to higher Sharpe ratios than their benchmark and positive information ratios. The one-way annualized index turnover, approximately in the 20 to 40% range for most indexes, has also been higher for factor indexes than for their parent. The MSCI ACWI Momentum Index saw higher turnover than other factors, close to 100%. The Momentum factor had a much faster decay and, hence, required more significant adjustments at index reviews. The MSCI ACWI Diversified Multi-Factor Index had the highest information ratio and the second-highest active return highlighting the benefits of diversifying exposures across a range of factors over this period.

Exhibit 3: MSCI ACWI Factor Indexes — Key Metrics

	MSCI ACWI Index	MSCI ACWI Enhanced Value Index	MSCI ACWI Equal Weighted Index	MSCI ACWI Momentum Index	MSCI ACWI Quality Index	MSCI ACWI HDY Index	MSCI ACWI Min. Vol. Index	MSCI ACWI DMF Index
Total return* (%)	4.7	8.9	7.2	8.1	6.8	6.0	7.6	8.1
Total risk (%)	15.5	18.5	17.5	16.3	14.0	15.1	10.4	16.1
Return / risk	0.31	0.48	0.41	0.49	0.48	0.40	0.72	0.50
Sharpe ratio	0.19	0.38	0.31	0.38	0.36	0.28	0.55	0.39
Active return (%)	0.0	4.2	2.5	3.3	2.0	1.3	2.8	3.4
Tracking error (%)	0.0	6.8	5.5	8.0	4.0	5.2	7.8	3.9
Information Ratio	nan	0.61	0.44	0.42	0.51	0.25	0.36	0.87
Historical beta	1.00	1.12	1.07	0.92	0.87	0.92	0.60	1.01
Number of constituents***	2457	694	2457	495	497	674	358	689
Turnover** (%)	3.1	30.6	18.8	92.8	22.6	19.6	24.1	40.1
Price to book***	2.2	1.0	1.6	3.1	4.4	2.0	2.5	1.9
Price to earnings***	18.2	13.8	21.9	21.7	17.2	13.7	18.9	13.6
Dividend yield*** (%)	2.3	2.8	2.5	1.7	2.1	4.0	2.7	2.3

Period: Dec 31, 1998 to Mar 31, 2020. * Gross returns annualized in USD ** Annualized one-way index turnover over index reviews *** Monthly averages

Exhibit 4: MSCI ACWI Factor Indexes — Relative Performance



Exposure Metrics

Active Exposures

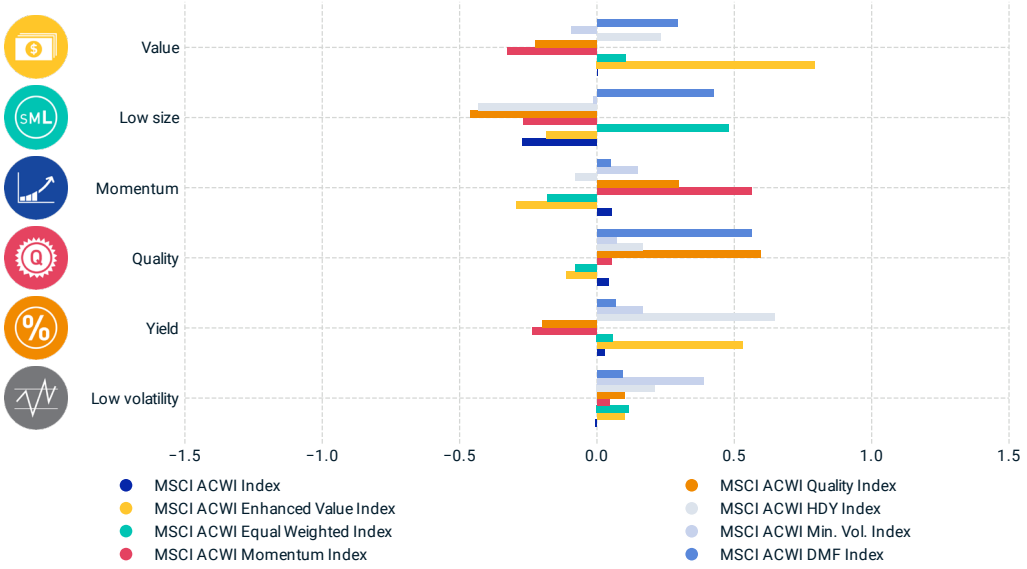
Given the historical risk and return profiles seen in the key metrics, investors may well wonder what active exposures the factor, ESG and thematic indexes have relative to their parent index. Monitoring these exposures is useful both before strategy implementation when selecting an index as well as post-implementation to monitor how the index exposures compared to the ones targeted by the methodology. For example, Exhibits 5 to 7 show the active exposure sections from IndexMetrics, which focus respectively on active factor group and sector exposures. For brevity, we show exposures for a subset of indexes in Exhibit 6 and Exhibit 7.

Factor group exposures are based on MSCI FaCS, which provides investors with a common language by which to think about factors. These are expressed in terms of standard deviations from those of the parent index. As a rule of thumb, an active exposure above 0.2 or below -0.2 standard deviations can be viewed as significant. Exhibit 5 shows that the MSCI factor indexes captured their intended exposures. For example, the MSCI ACWI Enhanced Value Index had the highest exposure to the value factor group among all indexes displayed, while the MSCI ACWI High Dividend Yield has the highest exposure to the yield factor group.

Exhibit 6 presents these factor group exposures into a historical context and shows that the four highest average factor group exposures of the MSCI ACWI Diversified Multi-Factor (DMF) Index were low size, momentum, quality and value. These factors are similarly targeted by the index methodology and contributed most to the historical outperformance of the index, as we will see in the last section of this paper. Average exposures to other factors groups have been less significant (these are constrained by the methodology not to exceed the 0.25 factor level at the semi-annual index review time).

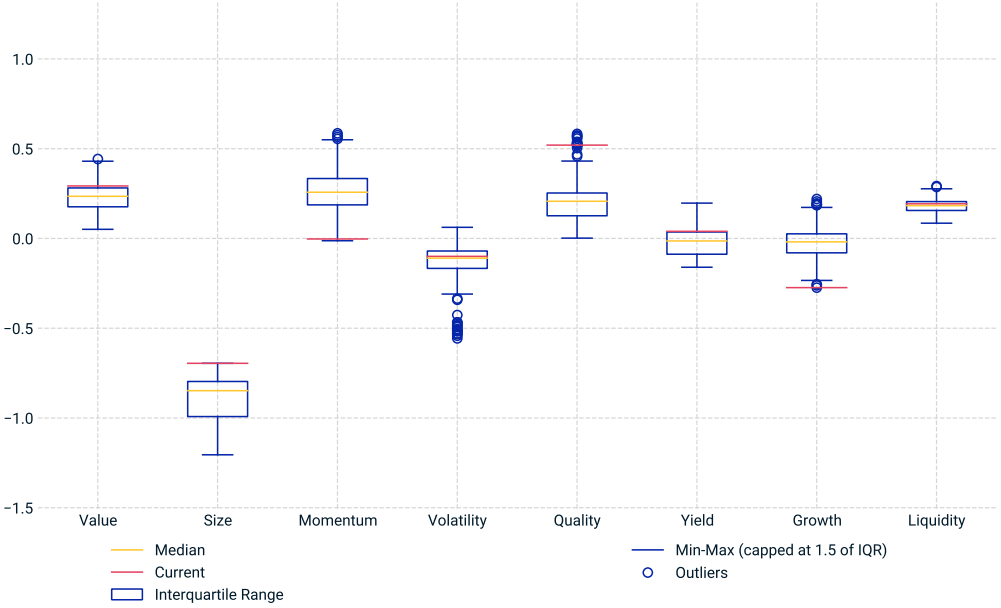
Exhibit 7 compares active sector exposures for the MSCI ACWI Diversified Multi-Factor Index and the MSCI ACWI Momentum Index. These exposures have been significantly more consistent and stable for the multi-factor index that uses optimization in its construction and explicitly controls for those than for the simpler rules-based MSCI ACWI Momentum Index. This index does not have such controls, thus resulting in significantly more active-sector-weight volatility.

Exhibit 5: MSCI ACWI Factor Indexes — Factor Box



As of March 31, 2020.

Exhibit 6: MSCI ACWI DMF Index — Active Factor Group Exposures



Period: Dec. 31, 1998 – March 31, 2020, monthly data.

Exhibit 7: MSCI ACWI DMF Index and MSCI ACWI Momentum Index — Active Sector Weights

Period: Dec. 31, 1998 – March 31, 2020, monthly data.

Financial Ratios[1]

The financial ratios section of IndexMetrics has both tabular and graphical components. The goal is to see how the financial ratios of the factor indexes compare to their parent index and how those changed over time. These metrics are described in Exhibit 8 below.

Exhibit 8: Financial Ratios Metrics

Metric	Definition
Price-to-book	Weighted harmonic mean of constituent price-to-book ratios
Price-to-cash-earnings	Weighted harmonic mean of constituent price-to-cash earnings ratios
Price-to-earnings	Weighted harmonic mean of constituent price-to-earnings ratios
Dividend yield	Weighted mean of constituent dividend yields
LT fwd EPS g	Weighted mean of constituent long-term forward EPS growth rates
Sustainable-growth rate	Derived from index-level return on equity, dividend yield and price-to-earnings
ROE	Weighted mean of constituent return on equity
Debt-to-equity	Weighted mean of constituent debt-to-equity ratios

Exhibit 9 below compares the average financial ratios of the MSCI ACWI factor indexes to their parent indexes and allows us to understand their characteristics better. We can see to what extent different factor indexes achieved the characteristics they targeted in terms of financial ratios. For example, the price-to-book ratio of the MSCI ACWI Enhanced Value Index has been 1.0 on average, which is significantly cheaper than the average of 2.2 for the MSCI ACWI Index. The MSCI ACWI Quality and MSCI ACWI DMF Indexes exhibited significantly lower leverage than the market (respectively 0.5 and 0.7 vs. 1.9), and the MSCI ACWI High Dividend Yield Index had an average yield of 4.0%, which was almost the double of the parent index (2.3%).

[1] Also refer to the MSCI fundamental data methodology for calculation details

Exhibit 9: MSCI ACWI factor indexes — Financial Ratios

	MSCI ACWI Index	MSCI ACWI Enhanced Value Index	MSCI ACWI Equal Weighted Index	MSCI ACWI Momentum Index	MSCI ACWI Quality Index	MSCI ACWI HDY Index	MSCI ACWI Min. Vol. Index	MSCI ACWI DMF Index
Price to book	2.2	1.0	1.6	3.1	4.4	2.0	2.5	1.9
Price to cash earnings	10.3	6.0	9.5	12.8	12.6	8.0	11.0	8.9
Price to earnings	18.2	13.8	21.9	21.7	17.2	13.7	18.9	13.6
Dividend yield (%)	2.3	2.8	2.5	1.7	2.1	4.0	2.7	2.3
LT fwd EPS g (%)	11.8	9.5	12.1	14.4	11.5	7.7	9.6	11.0
Sustainable growth rate (%)	7.2	4.8	3.8	9.2	16.5	6.8	6.4	9.4
ROE (%)	12.1	7.7	7.7	14.6	25.9	14.9	13.1	13.8
Debt to equity	1.8	1.7	1.4	1.4	0.5	1.9	1.1	0.7

Period: Jan 29, 1999 to Mar 31, 2020
Monthly averages

ESG Integration, Values and Norms

This section provides an overview of the ESG exposure of an index, as compared to its benchmark. These characteristics allow institutional investors to evaluate whether an index is aligned with their ESG objectives. This section is based on products such as MSCI ESG Ratings, MSCI ESG Controversies and MSCI Business Involvement Screening Research (BISR), provided by MSCI ESG Research LLC.

MSCI ESG Ratings provides research, analysis and ratings of how well companies manage financially relevant environmental, social and governance risks and opportunities. It provides an overall company ESG rating indicating how well a company manages each key issue relative to industry peers. It is derived by linearly mapping the MSCI Industry-adjusted ESG score to a seven-point rating scale between best (AAA) and worst (CCC). The key issues are assigned to each industry and company by identifying material risks and opportunities for each industry. This process is achieved via a quantitative model that considers ranges and average values for each industry for externalized impacts such as carbon intensity, water intensity and injury rates.

MSCI ESG Controversies provides assessments of controversies concerning alleged negative environmental, social and/or governance impacts of companies' operations, products and services. The evaluation framework used in MSCI ESG Controversies is designed to be consistent with international norms represented by the UN Declaration of Human Rights, the ILO Declaration on Fundamental Principles and Rights at Work, and the UN Global Compact. MSCI ESG Controversies scores fall within a scale of 0–10, with "0" being the most severe controversy.

MSCI ESG BISR aims to enable investors to manage ESG standards and restrictions reliably and efficiently. This allows investors to screen companies by religious, ethical and other relevant social and environmental criteria due to ESG controversies and allegations of breaches of international conventions and compliance with ESG guidelines, such as the UN Principles for Responsible Investment (UN PRI). Exhibit 10 details the definition of the ESG metrics.

Exhibit 10: ESG Integration, Values and Norms

Integration	Definition
ESG score	Weighted average ESG Score indicates how well the index companies manage their most material ESG risks relative to sector peers. Scores range from 10 (best) to 0 (worst).
ESG leaders (AAA-AA) (%)	Exposure to companies with an ESG rating of AAA or AA (best in class relative to peers)
ESG laggards (B-CCC) (%)	Exposure to companies with an ESG rating of B or CCC (worst in class relative to peers)
ESG trend positive (%)	Exposure to companies with a rating upgrade from the year prior to the most recent ESG rating
ESG trend negative (%)	Exposure to companies with a rating downgrade from the year prior to the most recent ESG rating
Index ESG rating	Indicates index-level ESG transparency to measure the ESG characteristics of an index with an AAA-CCC rating; Better rated indexes would have higher exposure to companies with leading or improved management of key ESG risks.
Environmental pillar score	Indicates how well the index companies manage their most material environmental risks. Scores range from 10 (best) to 0 (worst).
Social pillar score	Indicates how well the index companies manage their most material social risks. Scores range from 10 (best) to 0 (worst).
Governance pillar score	Indicates how well index companies manage their most material governance risks. Scores range from 10 (best) to 0 (worst).

Key Governance Metrics	Definition
Board independence (wtd avg %)	Weighted average % of independent board members
Female directors (wtd avg %)	Weighted average % of female board members
Deviation from one share one vote (%)	Exposure to companies flagged for any multiple equity classes with differential voting rights, golden shares or limitations on voting rights
Values and Norms	**Definition**
Tobacco involvement (%)	Exposure to companies flagged for involvement in tobacco; Specifically, tobacco producers and companies that derive 5% or more aggregate revenue from the manufacture, distribution, retailing, licensing and supply of tobacco products, as defined by the methodology of the MSCI Global ex Tobacco Involvement Indexes
Civilian firearms producers (%)	Exposure to civilian firearms producers
Ties to controversial weapons (%)	Exposure to companies with ties to controversial weapons; MSCI ESG Research's definition of controversial weapons cover cluster munitions, landmines, depleted uranium weapons, biological/chemical weapons, blinding lasers, non-detectable fragments and incendiary weapons, as defined by the methodology of the MSCI Global Ex-Controversial Weapons Indexes.
Global compact compliance violation (%)	Exposure to companies in violation of the UN Global Compact principles

Red-flag controversies (%)	Exposure to companies with environment-, governance-, customer-, human rights- or labor rights-related controversies that are assessed as "very severe"
Orange-flag controversies (%)	Exposure to companies with ongoing environment-, governance-, customer-, human rights- or labor rights-related controversies that are assessed as "severe" and indicate structural problems at the company

Exhibit 11 below compares the ESG metrics for the MSCI ACWI ESG Leaders Index with its parent index. The MSCI ACWI ESG Leaders index targets companies that have the highest ESG-rated performance in each sector of the parent index to ensure the inclusion of the best-in-class companies from an ESG perspective. As of the end of March 2020, the MSCI ACWI ESG Leaders Index had a superior ESG score as compared to the MSCI ACWI Index (7.1 vs. 6.0) with a higher representation of companies that were ESG Leaders (46.6% vs. 27.4%) and a lower representation of ESG Laggards (0 vs. 7.7%).

The best-in-class selection approach of the highest ESG-rated companies in each sector helps improve scores in each of the individual pillars; the Environmental, Social and Governance scores of the MSCI ACWI ESG Leaders Index were higher than the parent MSCI ACWI Index. Note that the overall ESG score is industry-adjusted, whereas the individual E, S and G pillar scores are not, thus explaining why the ESG score may fall outside the E, S and G score range.

The MSCI ESG Leaders Indexes use MSCI ESG Business Involvement Screening Research to identify companies involved in business activities such as alcohol, gambling and controversial weapons. Companies that meet the business involvement criteria are excluded from the MSCI ESG Leaders Indexes. This has historically helped the MSCI ACWI ESG Leaders Index show improvement along values and norms alignment. For example, the index, as of March 2020, had lower exposure to tobacco, controversial weapons and red flags.

Exhibit 11: MSCI ACWI ESG Leaders Index — ESG Integration, Values and Norms

Integration, values and norms

	MSCI ACWI Index	MSCI ACWI ESG Leaders Index
Integration		
ESG score	6.0	7.1
ESG leaders (AAA-AA) (%)	27.4	46.6
ESG laggards (B-CCC) (%)	7.7	0.0
ESG trend positive (%)	12.7	9.9
ESG trend negative (%)	4.4	5.7
Index ESG rating	A	AA
Environmental pillar score	5.6	6.2
Social pillar score	4.8	5.4
Governance pillar score	5.3	5.6
Key governance metrics		
Board independence (wtd avg %)	75.4	76.8
Female directors (wtd avg %)	27.0	28.1
Deviation from one share one vote (%)	24.1	25.2
Values and norms		
Tobacco involvement (%)	1.1	0.4
Civilian firearms producers (%)	0.2	0.2
Ties to controversial weapons (%)	0.6	0.0
Global compact compliance violation (%)	2.0	0.0
Red flag controversies (%)	2.5	0.0
Orange flag controversies (%)	26.5	18.1

As of March 31, 2020

ESG Climate Change

This section provides an overview of the ESG climate change exposure of the index in comparison with its benchmark. It is based on the MSCI ESG CarbonMetrics and MSCI Climate Change Metrics.

MSCI ESG CarbonMetrics provides a variety of metrics for assessing the carbon characteristics of an index or investment portfolio, including carbon emissions data for all constituents of the MSCI ACWI Investable Markets Index (IMI). These metrics help investors access climate risk exposure in the form of carbon emissions and intensities. The climate risk exposure can be accessed as reported and estimated by assessment of corporate issuers' carbon exposure and management practices to identify leaders and laggards regarding preparedness for transitioning to a low carbon economy.

MSCI Climate Change Metrics is designed to support investors seeking to achieve a range of objectives, including measuring and reporting climate risk exposure, implementing low-carbon and fossil-fuel-free strategies and factoring climate change research into their risk management processes. It provides carbon emissions, fossil fuel exposure, environmental impact (i.e., clean technology) data and screens, as well as climate-related risk exposure and management assessment on companies. Exhibit 12 defines the carbon exposure metrics used in IndexMetrics.

Exhibit 12: Climate Change

Climate Footprint	Definition
Carbon emissions (t CO2e/$M invested)	Scope 1 + Scope 2 carbon emissions normalized for the index
Carbon intensity (t CO2e/$M sales)	Efficiency of the index in terms of total Scope 1 and Scope 2 carbon emissions divided by total sales
Weighted average carbon intensity (t CO2e/$M sales)	Exposure to carbon-intensive companies based on Scope 1 and Scope 2 emissions
Low Carbon Transition Risks	**Definition**
Low-carbon transition score	Weighted average low-carbon transition (LCT) score measuring companies' level of alignment to the LCT; Scores range from 0 to 10.
Solutions (%)	Exposure to companies involved in low/zero carbon solutions that would have negative total carbon intensity and may benefit in a low carbon scenario
Product and operational transition (%)	Exposure to companies with moderately to highly carbon-intensive products or operations; The products or operations of such companies could undergo a transition in a low carbon scenario.
Asset stranding (%)	Exposure to companies with very high-risk exposure to transition risk that may face asset stranding risk in the short to medium term
Exposure to Asset Stranding Risks	**Definition**
Potential carbon emissions (t CO2e/$M invested)	Potential carbon emissions normalized for the index
Fossil fuel reserves (%)	Exposure to companies that own proven and probable coal or oil and natural gas reserves used for energy purposes; The definition is based on the MSCI Global Ex-Fossil Fuel Indexes Methodology.

Thermal coal mining (%)	Exposure to companies that derive some of their revenue from thermal coal mining
Thermal coal-based power generation (%)	Exposure to companies that derive some of their revenue from thermal coal-based power generation
Unconventional oil and gas extraction (%)	Exposure to companies that derive revenues from unconventional oil and gas, including oil sands, oil shale, shale gas, shale oil, coal seam gas and coal bed methane; It excludes all types of conventional oil and gas production.
Exposure to Clean Technology Solutions	**Definition**
Clean technologies solutions (> 20% revenue)	Exposure to companies that derive 20% or more revenue from any of the five cleantech themes: Alternative energy, energy efficiency, green building, pollution prevention or sustainable water
Clean technologies solutions revenue (wtd avg %)	Weighted average % revenue derived from any of the five cleantech themes, including alternative energy, energy efficiency, green building, pollution prevention or sustainable water
Green/brown net revenue exposure	The ratio of the weighted average clean technologies solutions revenue (%) or "green revenue" to the weighted average fossil fuel revenue (%) or "brown revenue," which is defined as the weighted average % revenue derived from any of the fossil-fuel-related activities including thermal coal mining, oil and gas extraction, thermal coal-based power generation and oil and gas-based power generation

Other Climate Metrics	Definition
Exposure to carbon-related assets (%)	exposure to companies that belong to the following the global industry classification standard (GICS®)[2] industries: energy equipment & services (101010), oil, gas & consumable fuels (101020), electric utilities (551010), gas utilities (551020) and multi-utilities (551030)
Climate-related controversies (%, score ≤ 4)	Exposure to companies with climate change and energy-related controversies that are flagged as red, orange and yellow and have scores from 0 to 4; Factors affecting this evaluation include a history of involvement in GHG-related legal cases, widespread or egregious impacts due to corporate GHG emissions, resistance to improved practices and criticism by NGOs or other third-party observers.
Low carbon transition management score (% top quartile)	Exposure to companies in the top quartile in terms of their low carbon transition management score relative to companies in the relevant GICS sub-industry that are constituents of the MSCI ACWI IMI

MSCI Global Low Carbon Target Indexes are designed to address two dimensions of carbon exposure — carbon emissions and fossil fuel reserves — as measured by the potential carbon emissions. These indexes aim to achieve at least a 50% reduction in the carbon footprint of the parent index by excluding companies with the highest carbon emissions intensity and the largest owners of carbon reserves (per USD of market capitalization). They also aim to minimize the tracking error relative to their parent index. Exhibit 13 below shows that MSCI ACWI Low Carbon Target Index achieved an approximately 80% reduction in carbon emissions and a more than 99% reduction in potential carbon emissions, as of the end of March 2020.

[2] GICS, the global industry classification standard jointly developed by MSCI and Standard & Poor's.

MSCI Climate Change Indexes aim to represent the performance of an investment strategy that re-weights securities based on the opportunities and risks associated with the transition to a lower-carbon economy while seeking to minimize exclusions from the parent index. The methodology uses the MSCI Low Carbon Transition Risk Assessment to reweight constituents of the parent index and increase its exposure to companies participating in opportunities associated with the transition while decreasing its exposure to companies exposed to transition risks.

MSCI ESG Research's Low Carbon Transition Risk assessment is designed to identify potential leaders and laggards by holistically measuring companies' exposure to and management of risks and opportunities related to the low carbon transition. The final output of this assessment is given as two company-level factors as described below:

1. Low Carbon Transition Category: This factor groups companies into five categories (asset stranding, product, operational transition, neutral and solutions) that highlight the predominant risks and opportunities they are most likely to face in the transition.
2. Low Carbon Transition Score: This score (ranging from 0 to 10) is based on a multi-dimensional risks and opportunities assessment and considers both the predominant and secondary risks a company faces. It is industry agnostic and represents an absolute assessment of a company's position vis-à-vis the transition.

Exhibit 13 below indicates that the MSCI ACWI Climate Change Index had reduced low carbon transition risks, higher exposure to clean technology solutions and improvement in other climate metrics as of March 2020.

Exhibit 13: MSCI ACWI Low Carbon Target and Climate Change Indexes — Climate Change

	MSCI ACWI Index	MSCI ACWI Low Carbon Target Index	MSCI ACWI Climate Change Index
Climate footprint			
Carbon emissions (t CO2e/$M invested)	166	32	82
Carbon intensity (t CO2e/$M sales)	224	47	127
Wtd avg carbon intensity (t CO2e/$M sales)	181	58	101
Low carbon transition risks			
Low carbon transition score	6.1	6.2	6.4
Solutions (%)	2.9	3.2	7.3
Product & operational transition (%)	16.0	11.3	7.8
Asset stranding (%)	0.3	0.0	0.0
Exposure to asset stranding risks			
Potential carbon emissions (t CO2e/$M invested)	3763	16	738
Fossil fuel reserves (%)	5.6	2.6	2.1
Thermal coal mining (%)	1.3	1.4	0.6
Thermal coal-based power generation (%)	3.5	1.7	2.0
Unconventional oil & gas extraction (%)	2.6	0.7	0.5
Exposure to clean technology solutions			
Clean technologies solutions (> 20% revenue)	4.2	4.5	8.2
Clean technologies solutions revenue (wtd avg %)	3.6	3.7	5.3
Green/brown net revenue exposure	1.9	10.5	8.3
Other climate metrics			
Exposure to carbon-related assets (%)	7.0	4.4	2.5
Climate-related controversies (%, score ≤ 4)	0.7	0.3	0.3
Low carbon transition management score (% top quartile)	66.7	67.4	70.1

As of March 31, 2020

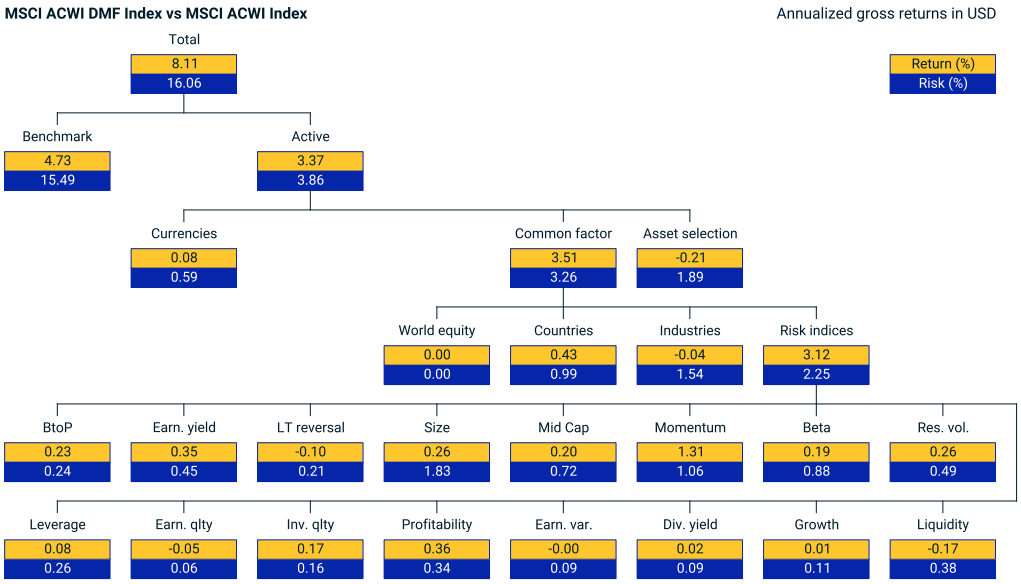
Performance Metrics

Performance metrics are important tools to gain insights into the underlying exposures driving excess returns and risks. They help institutional investors evaluate if target exposures contributed to excess performance. Most of this section employs MSCI's Barra equity risk models to provide a deep analysis of the index return sources.

Performance Attribution Tree

Exhibit 14 illustrates the performance attribution capabilities of the framework using the MSCI ACWI DMF Index, as an example, and the MSCI Global Total Market Equity Model for Long-Term Investors (GEMLT). The index had an annualized return of 8.11% between Dec. 31, 1998, and March 31, 2020; that was 3.37% above the benchmark. This active return mainly came from style factors (also called risk indices) with a contribution of 3.12%. This active return source was also the most volatile among common factor groups, with an annualized standard deviation of 2.25%. Examining individual style factor return contributions further reveals that this outperformance largely came from intended factor exposures; that is, factors the DMF Index methodology explicitly targets: value, low size, momentum and quality.

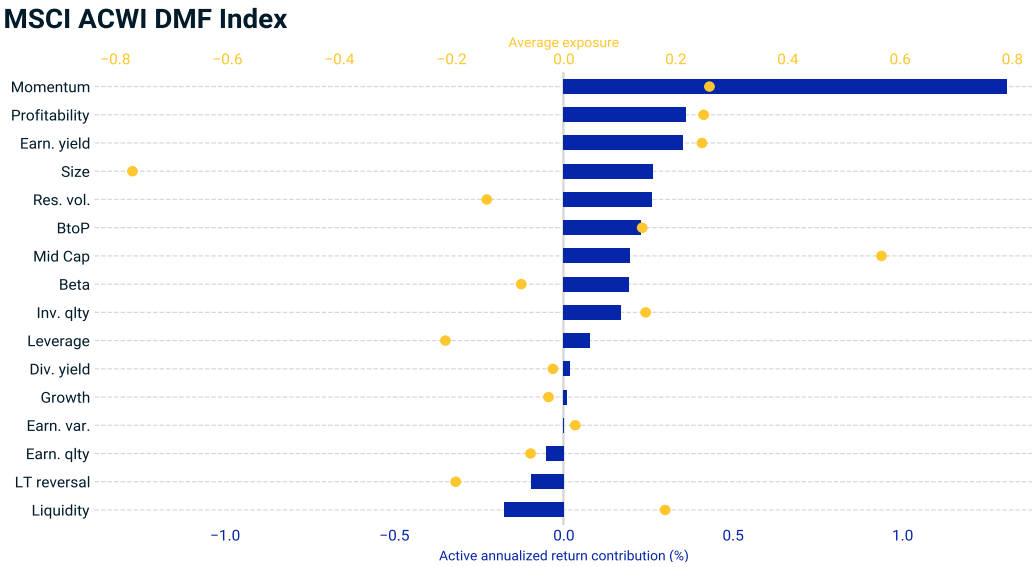
Exhibit 14: MSCI ACWI DMF Index: Performance Attribution using the GEMLT



Period: Dec 31, 1998 to Mar 31, 2020

The performance attribution section includes analysis results on the exposure and performance contributions from style factors, countries and industries at a more granular level. Exhibit 15, for example, shows the exposure and performance contribution for each style factor.

Exhibit 15: Performance Attribution — Styles



This section also provides information on stocks that contributed significantly to the index performance over the past three months. Exhibit 16 shows the top- and bottom-five contributors to the excess performance.

Exhibit 16: Top and Bottom Contributions

MSCI ACWI DMF Index: top contributors

	Country	Sector	Weight (%)	Active weight (%)	Active return (-3M, %)	Return contribution (-3M, bps)
ROCHE HOLDING GENUSS	SWITZERLAND	Health Care	2.96	2.39	24.28	58.00
BIOGEN	USA	Health Care	1.50	1.36	27.88	37.84
INTEL CORP	USA	Information Technology	2.96	2.37	12.13	28.76
CHINA CONSTRUCTION BK H	CHINA	Financials	1.90	1.70	15.96	27.18
PROGRESSIVE CORP	USA	Financials	1.11	1.00	26.55	26.60

As of Mar 31, 2020. Gross USD returns. Contributions are estimated by multiplying the active weight with active quarterly return

MSCI ACWI DMF Index: bottom contributors

	Country	Sector	Weight (%)	Active weight (%)	Active return (-3M, %)	Return contribution (-3M, bps)
MICROSOFT CORP	USA	Information Technology	0.27	-2.60	21.54	-56.05
AMAZON.COM	USA	Consumer Discretionary	0.00	-2.07	26.77	-55.32
APPLE	USA	Information Technology	0.53	-2.31	8.06	-18.65
TENCENT HOLDINGS LI (CN)	CHINA	Communication Services	0.00	-0.71	23.02	-16.27
NETFLIX	USA	Communication Services	0.00	-0.41	37.31	-15.44

As of Mar 31, 2020. Gross USD returns. Contributions are estimated by multiplying the active weight with active quarterly return

Risk Profile

This section describes the index total, relative and tail-risk properties. Investors have varying focuses on absolute risk, tracking error and drawdowns, and the risk profile section aims to show a broad selection of these measures. Exhibit 17 describes the various statistics used to assess risk.

Exhibit 17: Risk Profile

Absolute Risk Metrics	Definition
Total risk (%)	Annualized total risk is a measure of the index return dispersion. It is calculated by annualizing the standard deviation of monthly index returns.
Downside deviation (%)	Considers only the volatility of negative returns.
Sortino ratio	A modification of the Sharpe ratio that penalizes only returns that fall below a certain target (termed as minimum acceptable return). For IndexMetrics, we set this target to 0.

VaR @ 95%	A measure of the risk of loss. For a 95% confidence level, it is reported as the 5th percentile of historical monthly returns of an index.
VaR @ 99%	A measure of the risk of loss. For a 99% confidence level, it is reported as the 1st percentile of historical monthly returns of an index.
Expected shortfall (CVaR) @ 95%	Also called conditional VaR, it is defined as the average of returns below Var @ 95% (based on monthly returns)
Expected shortfall (CVaR) @ 99%	Also called conditional VaR, it is defined as the average of returns below Var @ 99% (based on monthly returns)
Maximum drawdown	The drawdown is a measure of the decline of an index from its peak. The maximum drawdown is its maximum value over the full period of analysis.
Maximum drawdown period (months)	Measures the duration of the maximum drawdown. It is expressed in months.
Skewness	A measure of the asymmetry of the historical index return distribution. A negative skewness means that the tail on the left side of the distribution is larger than the right side.
Kurtosis	A measure of the sharpness of the peak of the historical index return distribution. A distribution with positive kurtosis is termed as leptokurtic and has fatter tails. A distribution with negative kurtosis is termed as platykurtic and has thinner tails.

Relative Risk Metrics	Definition
Tracking error (%)	Also called active risk, it measures the dispersion of excess returns of an index relative to its benchmark. It is calculated by annualizing the standard deviation of active returns.
Maximum drawdown of active returns (%)	The largest decline of the index relative to its benchmark.
Maximum Drawdown of Active Returns Period (months)	Measures the duration of the maximum drawdown of active returns. It is expressed in months.

Exhibit 18 shows the risk profile for the MSCI factor indexes in tabular form. This analysis shows that total risk varied across factor indexes, with some having higher and others lower volatility than the market between Dec. 1998 and March 2020. The MSCI ACWI Minimum Volatility Index, which is designed to achieve lower volatility, stands out in this analysis: its total risk was 10.4% vs. 15.5% for the MSCI ACWI Index. Its other risk measures, such as downside deviation, VaR and CVaR, were also superior to the other factor indexes during the observed period. Another interesting statistic is the period of the maximum drawdown of active returns. While all factor indexes outperformed the market during the observed period, the top outperformer (the MSCI ACWI Enhanced Value Index, as seen in Exhibit 3) had a consecutive period of 125 months of underperformance (more than 10 years). By contrast, the MSCI ACWI High Dividend Yield had a maximum active return drawdown period of 10 months.

Exhibit 18: Key Risk Metrics

	MSCI ACWI Index	MSCI ACWI Enhanced Value Index	MSCI ACWI Equal Weighted Index	MSCI ACWI Momentum Index	MSCI ACWI Quality Index	MSCI ACWI HDY Index	MSCI ACWI Min. Vol. Index	MSCI ACWI DMF Index
Absolute risk metrics								
Total risk* (%)	15.5	18.5	17.5	16.3	14.0	15.1	10.4	16.1
Downside deviation* (%)	11.0	12.1	12.0	11.3	9.6	10.4	7.2	11.2
Sortino ratio*	0.43	0.73	0.60	0.71	0.71	0.58	1.05	0.72
VaR @ 95% (%)	-8.2	-8.5	-8.1	-7.5	-7.3	-7.7	-5.0	-8.1
VaR @ 99% (%)	-11.7	-13.0	-14.4	-13.3	-9.0	-12.1	-8.3	-12.8
Expected shortfall (CVaR) @ 95% (%)	-10.5	-11.8	-11.9	-10.7	-9.1	-10.7	-7.2	-10.8
Expected shortfall (CVaR) @ 99% (%)	-15.2	-16.6	-18.1	-15.8	-12.6	-14.9	-11.1	-16.6
Maximum drawdown (%)	-58.1	-61.3	-60.4	-60.4	-49.6	-61.5	-42.9	-58.2
Maximum drawdown period (months)	16	16	16	16	16	16	16	16
Skewness	-0.72	-0.38	-0.64	-0.61	-0.64	-0.61	-1.06	-0.86
Kurtosis	4.71	4.25	5.76	4.71	4.15	5.45	5.58	5.45
Relative risk metrics								
Tracking error* (%)	0.0	6.8	5.5	8.0	4.0	5.2	7.8	3.9
Maximum active returns drawdown (%)	0.0	-28.3	-27.2	-24.1	-20.0	-20.0	-19.3	-10.5
Maximum active returns drawdown period (months)	0	125	113	19	52	10	26	23

Period: Dec 31, 1998 to Mar 31, 2020. * Annualized in USD

Investability Metrics

One of the approaches used to try and enhance targeted factor exposures is to tilt away from market capitalization weights using factor exposures. However, an unavoidable tradeoff exists between the intensity of factor exposures and index investability, where factor exposure can usually only be increased by reducing the index capacity, impacting index liquidity and trading costs. It is why we look at the investability metrics of the index along with its other characteristics.

Capacity and Concentration

The capacity and concentration, along with the liquidity and cost of replication sections in IndexMetrics, aim to provide a snapshot and historical overview of the investability of an index and how it has evolved. In particular, the capacity and concentration metrics define the capacity of a factor index as the percentage of a stock's free float or full market capitalization that a fund replicating the index would own for a given fund size. When combined with a limit on percentage ownership, this metric can be used to evaluate the capacity of the fund (i.e., the total amount that could be invested into the factor index given these limits).

Exhibit 19: Capacity and Concentration

Concentration Metrics	Definition
Average number of constituents	Monthly average of the number of index constituents
Effective number of constituents	A measure of index concentration that ranges between 1 (weight of the index concentrated in a single stock) and n, (the total number of constituents of the index). Everything else being equal, a low effective number of constituents can be interpreted as a high concentration of the index. It is calculated as the inverse of the Herfindahl-Hirschman Index (HHI).
Parent index coverage	The market capitalization coverage, which measures the weight overlap of the factor index with its benchmark.
Top-10 constituents weight	A measure of concentration. It is calculated as the sum of the weights of the ten largest constituents of the index.

Size Family Exposures	Definition
Large/Mid/Small/Micro	Weight of large/mid/small/micro-cap stocks in the index
Capacity Metrics	**Definition**
Stock ownership	Calculated as the percentage ownership of stock's full or float market capitalization in a fund that perfectly replicates the index, assuming a default fund size of USD 1 billion.
Average	Average stock ownership of the index
95th percentile	95th percentile of stock ownership of the index.
Maximum	Maximum stock ownership of the index
Active Tilt Metrics	**Definition**
Active share	A measure of active tilt of the factor index relative to its benchmark. It is defined as the distance between the factor index and its benchmark using the one-way turnover metric.
Average weight multiplier	Monthly average of the ratio of the weight of a constituent in an index relative to its benchmark.
Maximum weight multiplier	Maximum of the ratio of the weight of a constituent in an index relative to its benchmark over the full analysis period
Maximum weight	Maximum constituent weight in the index over the full analysis period

IndexMetrics uses measures such as active share and weight multiplier to capture the degree to which a factor index is active relative to its parent index. We defined IndexMetrics measures that capture the concentration and capacity of an index in Exhibit 19 above. Exhibits 20 and 21, respectively, give a tabular (split by component) and graphical (over time and relative to the parent) representations of index concentration and capacity.

Exhibit 20: MSCI ACWI Factor Indexes — Capacity and Concentration Table

	MSCI ACWI Index	MSCI ACWI Enhanced Value Index	MSCI ACWI Equal Weighted Index	MSCI ACWI Momentum Index	MSCI ACWI Quality Index	MSCI ACWI HDY Index	MSCI ACWI Min. Vol. Index	MSCI ACWI DMF Index
Concentration*								
Average number of constituents	2457	694	2457	495	497	674	358	689
Effective number of constituents	374	152	2377	98	76	110	186	214
Parent index coverage (%)	100.0	18.1	100.0	23.9	31.4	30.8	31.3	11.9
Top 10 constituents weight (%)	10.5	17.7	0.8	24.5	27.9	22.3	12.6	14.5
Size family exposures**								
Large (%)	83.1	82.5	48.3	79.3	87.6	89.9	74.0	46.4
Mid (%)	16.9	17.5	51.7	20.7	12.4	10.1	26.0	53.6
Small (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Micro (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Index capacity - float market cap ownership***								
Average (%)	0.02	0.14	0.10	0.07	0.06	0.09	0.18	0.19
95th percentile (%)	0.02	0.28	0.34	0.11	0.09	0.09	0.41	0.21
Maximum (%)	0.02	0.54	0.93	0.13	0.17	0.09	0.43	0.41
Index capacity - full market cap ownership***								
Average (%)	0.01	0.10	0.05	0.05	0.05	0.06	0.12	0.14
95th percentile (%)	0.02	0.21	0.16	0.10	0.08	0.09	0.36	0.21
Maximum (%)	0.02	0.49	0.56	0.12	0.09	0.09	0.41	0.21
Degree of index tilt*								
Active share (%)	0.0	81.9	54.2	76.1	68.6	69.2	75.2	88.8
Average weight multiplier	1.0	9.6	11.3	5.1	3.3	3.4	10.0	9.7
Maximum weight multiplier	1.0	57.5	1056.7	8.8	4.9	3.6	20.1	10.2
Maximum weight (%)	1.9	3.3	0.1	4.7	5.0	3.6	1.6	2.4

Period: Dec 31, 1998 to Mar 31, 2020
* Monthly averages

** Monthly averages, size family data available from June 2008

*** Assuming a fund size of USD 10.0 bn as of the latest index review on November 26, 2019

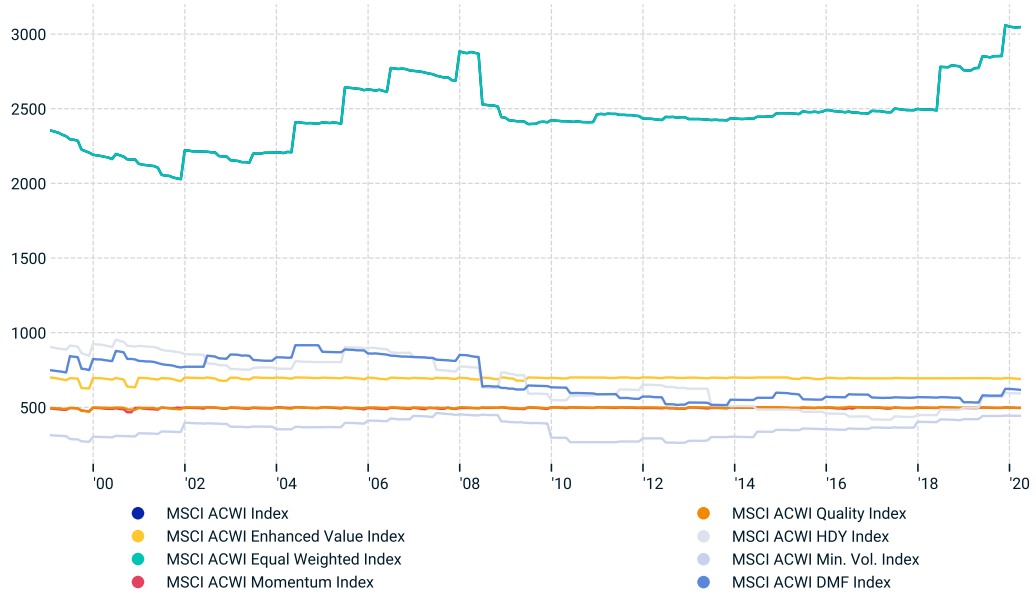
Exhibit 20 shows the concentration and capacity metrics for the MSCI ACWI factor indexes along with the parent MSCI ACWI Index. We calculated index capacity assuming a fund size of USD 10 billion, where the capacity metrics are linearly proportional to the fund size.

The table above shows that for the analysis period, the highest average free-float stock ownership among the factor indexes was the MSCI ACWI DMF Index at 19 basis points (bps), with the MSCI ACWI Minimum Volatility Index at a close second with an average free-float holding of 18 bps. The maximum weight multiplier and maximum strategy weight for these two optimized indexes are controlled as a result of the constraints on maximum weight each constituent can take.

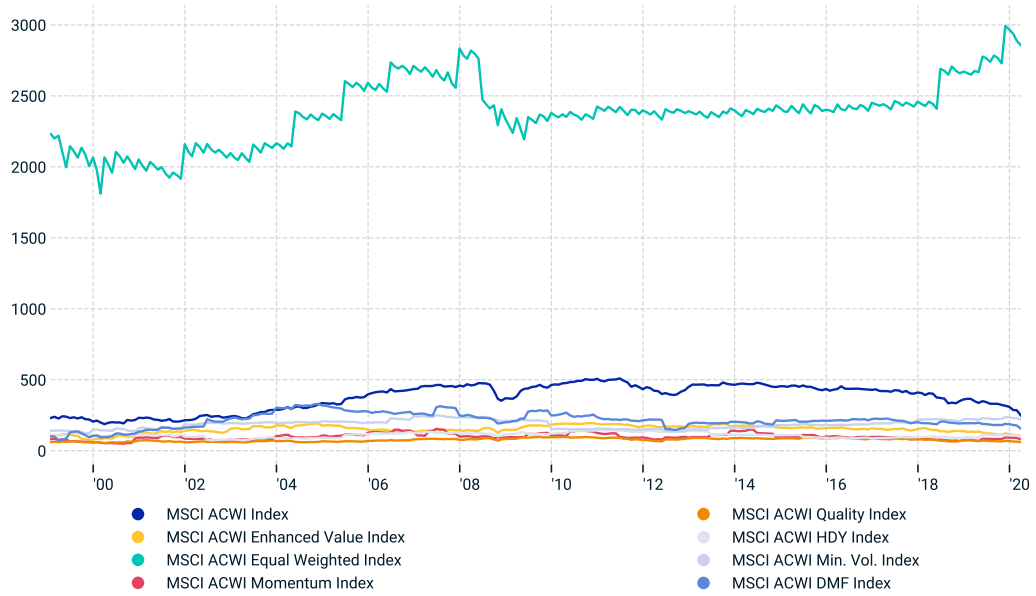
Finally, Exhibit 21 shows the capacity characteristics graphs spanning approximately 20 years. The MSCI ACWI DMF Index, on average, covered 11.9% of the MSCI ACWI.

Exhibit 21: MSCI ACWI Factor Indexes — Capacity and Concentration Graphs

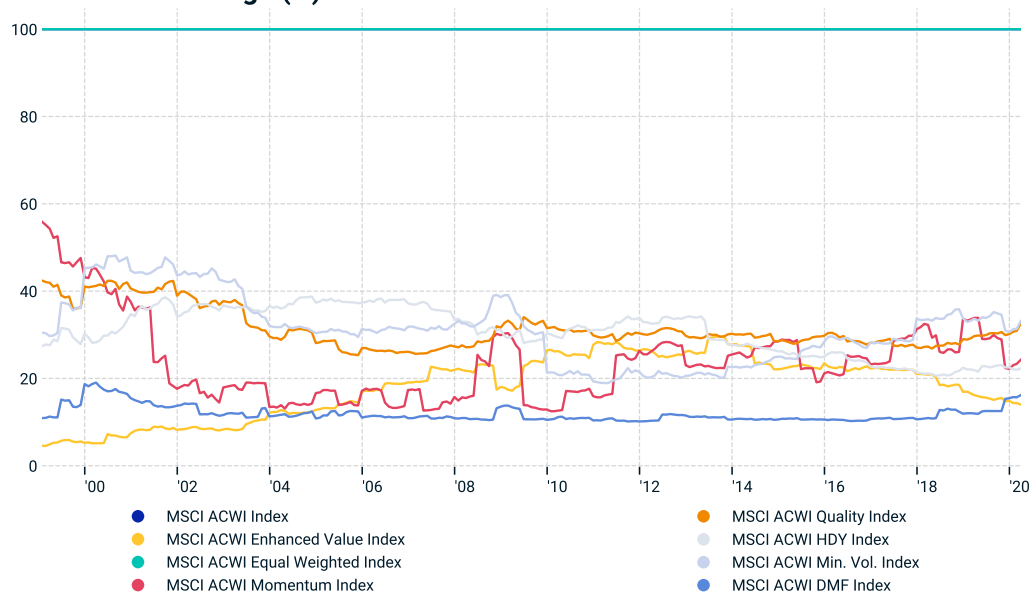
Number of constituents



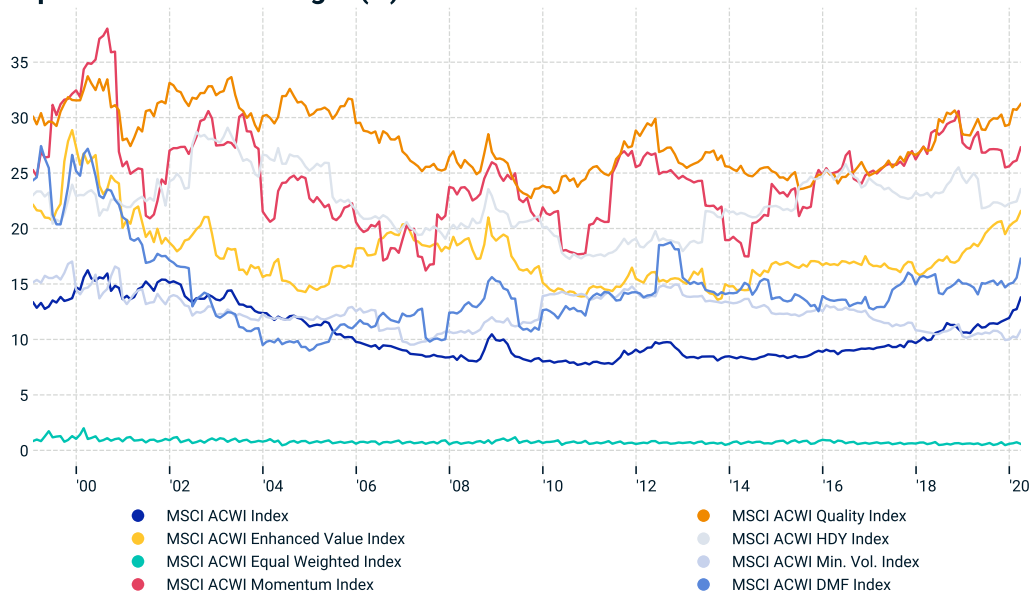
Effective number of constituents



Benchmark coverage (%)



Top 10 constituents weight (%)



Liquidity and cost of replication

The liquidity and cost of replication metrics in IndexMetrics aim to provide insights on the liquidity and tradability of indexes along with the parent index. It helps institutional investors quantify the tradeoff between any potential risk-adjusted return benefits of factor indexes and the increased implementation and replication costs.

Liquidity metrics aim to quantify the index tradability by considering the weighted average liquidity of the individual stocks in the index. It also provides a "days to trade" measure indicating the average number of days needed to invest USD 10 billion in the index, given a constraint of not trading for more than 20% of the daily liquidity of any security (once again, all these effects are assumed to be linear in the size of the allocation). These measures are shown on an average and a tail basis. Finally, replication costs indicate the costs of replicating the index. The higher the turnover, the higher the cost of trading and consequently, the higher the performance drag. Importantly, these metrics are not an estimate of the actual market impact, which would require the use of more sophisticated (usually non-linear) trading cost models.

Below, exhibit 22 defines the liquidity and turnover metrics used in IndexMetrics, and exhibit 23 shows the metrics for the factor indexes. Finally, Exhibit 24 shows how the one-way index turnover has evolved for these indexes, compared to the parent.

Exhibit 22: Liquidity and Cost of Replication

Liquidity metrics	Definition
Weighted average ATVR[1]	Weighted mean of the security level annualized traded value ratio (ATVR) that provides a measure of liquidity for a security
Days to trade	Provides a measure of liquidity and corresponds to the number of days required to implement a change in the index. We report days to trade relative to the benchmark (rebalancing away from the benchmark to the factor index), for a periodic index review (rebalancing from pre- to post-rebalancing weights) and relative to cash (rebalancing away from cash to the factor index).

Days to trade – Weighted average	Weighted mean of days to trade
Days to trade – 95th percentile	95th percentile of days to trade
Days to trade – Maximum	Maximum days to trade
Days to complete 95% trading	Number of days to complete 95% of trading volume
Cost of replication metrics	**Definition**
Turnover	Measures the percentage change in the composition of an index at each index review. We report the annualized one-way index turnover over the full period of analysis.
Performance drag	Measures an approximate impact of the index review on performance, assuming different fixed trading costs. It is calculated by multiplying the one-way index turnover by the trading cost assumption (25, 50 and 75 bps).

Exhibit 23: MSCI ACWI Factor Indexes – Liquidity and Cost of Replication

	MSCI ACWI Index	MSCI ACWI Enhanced Value Index	MSCI ACWI Equal Weighted Index	MSCI ACWI Momentum Index	MSCI ACWI Quality Index	MSCI ACWI HDY Index	MSCI ACWI Min. Vol. Index	MSCI ACWI DMF Index
ATVR* (%)	141.4	133.7	265.3	134.8	124.6	100.3	115.4	160.7
Days to trade - periodic index review**								
Average	0.0	0.4	0.3	0.8	0.2	0.3	0.7	0.9
95th percentile	0.1	1.4	1.1	2.5	1.2	1.8	3.9	4.3
95% of all trading volume	1.2	1.9	19.4	1.6	1.4	2.2	4.1	3.5
Maximum	2.1	7.9	21.9	10.0	6.8	10.4	23.7	20.8
Days to trade - relative to benchmark***								
Average	0.0	0.7	1.1	0.5	0.4	0.5	0.7	0.7
95th percentile	0.0	2.6	4.4	1.6	1.1	1.5	3.4	3.1
95% of all trading volume	0.0	3.6	49.2	1.6	0.9	1.4	4.9	2.4
Maximum	0.0	13.7	33.3	8.4	4.6	8.3	22.6	19.5
Days to trade - relative to cash***								
Average	0.3	2.1	1.3	1.7	1.1	1.5	3.5	2.6
95th percentile	0.7	6.1	4.9	3.8	2.7	3.5	12.4	5.9
95% of all trading volume	0.4	5.1	49.2	2.4	1.7	2.3	6.5	3.3
Maximum	2.4	14.2	34.3	9.7	6.3	10.7	23.8	21.7
Cost of replication								
Turnover** (%)**	3.1	30.6	18.8	92.8	22.6	19.6	24.1	40.1
Performance drag at 25 bps*** (bps)**	1.6	15.3	9.4	46.4	11.3	9.8	12.1	20.1
Performance drag at 50 bps*** (bps)**	3.1	30.6	18.8	92.8	22.6	19.6	24.1	40.1
Performance drag at 75 bps*** (bps)**	4.7	45.9	28.2	139.2	33.8	29.3	36.2	60.2

* As of March 31, 2020

** Average of last four index reviews ending March 31, 2020 and assuming a fund size of USD 10.0 bn and a maximum daily trading limit of 20%

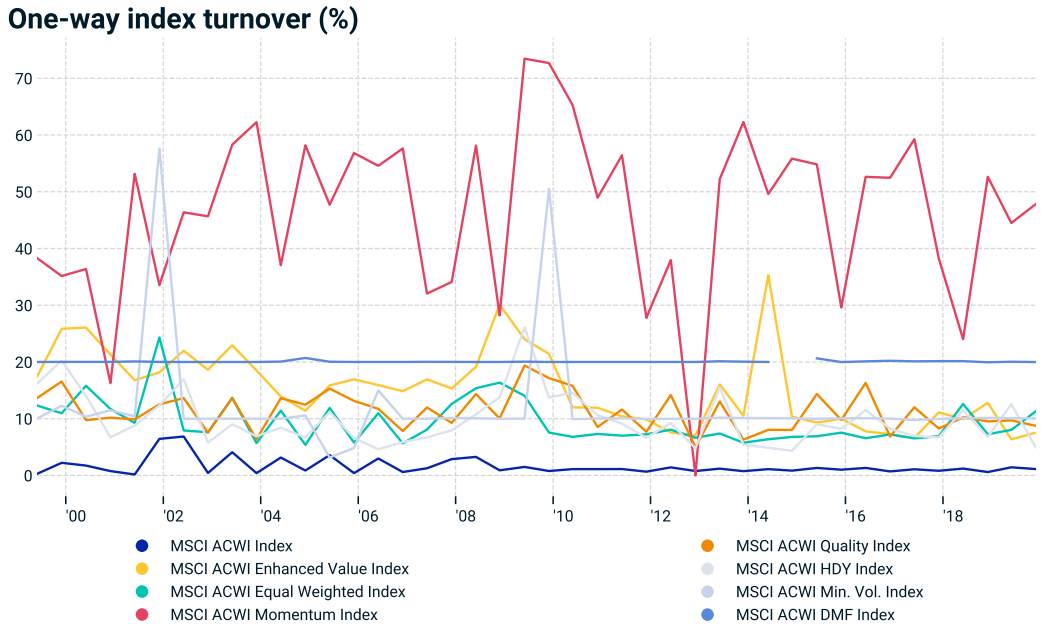
*** As of the latest index review on November 26, 2019

**** Annualized one-way index turnover over index reviews

***** Performance drag aims to represent the total two-way annualized index level transaction cost assuming various levels of security level transaction cost

The weighted average ATVR for the MSCI ACWI Equal Weighted Index was the highest among all the ACWI factor indexes. Exhibit 24 below shows that one-way turnover for the MSCI ACWI Minimum Volatility and MSCI ACWI DMF indexes was constrained to a maximum of 10% and 20%, respectively, at each semi-annual index review (SAIR).

Exhibit 24: MSCI ACWI Factor Indexes — Index Review Turnover



Top Constituents and Top Active Positions

While IndexMetrics provides comprehensive insights into index characteristics, it also shows the top 20 constituents of an index by weight as well as the top- and bottom-20 constituents of the index by active weight. All three are shown together in Exhibit 25.

Exhibit 25: MSCI ACWI DMF Index – Top Constituents and Top and Bottom Active Positions

MSCI ACWI DMF Index: top constituents by weight

	Country	Sector	Weight (%)	Active weight (%)	ESG rating
INTEL CORP	USA	Information Technology	2.96	2.37	A
ROCHE HOLDING GENUSS	SWITZERLAND	Health Care	2.96	2.39	A
CHINA CONSTRUCTION BK H	CHINA	Financials	1.90	1.70	BBB
INTUIT	USA	Information Technology	1.54	1.39	AA
BIOGEN	USA	Health Care	1.50	1.36	A
ACCENTURE A	USA	Information Technology	1.48	1.22	AAA
RIO TINTO PLC (GB)	UNITED KINGDOM	Materials	1.34	1.21	A
TARGET CORP	USA	Consumer Discretionary	1.22	1.10	A
MICRON TECHNOLOGY	USA	Information Technology	1.19	1.08	BBB
CHINA MOBILE	CHINA	Communication Services	1.18	1.06	BB
PROGRESSIVE CORP	USA	Financials	1.11	1.00	BBB
BAXTER INTERNATIONAL	USA	Health Care	1.01	0.91	BB
AON PLC A	USA	Financials	1.00	0.90	BB
DOLLAR GENERAL CORP	USA	Consumer Discretionary	1.00	0.90	B
SK HYNIX	KOREA	Information Technology	0.96	0.87	BB
KONINKLIJKE PHILIPS	NETHERLANDS	Health Care	0.94	0.85	A
WALGREENS BOOTS ALLIANCE	USA	Consumer Staples	0.90	0.82	BBB
BHP GROUP (GB)	UNITED KINGDOM	Materials	0.84	0.76	BBB
ROSS STORES	USA	Consumer Discretionary	0.82	0.74	BB
NTT CORP	JAPAN	Communication Services	0.79	0.71	A

As of Mar 31, 2020

MSCI ACWI DMF Index: top constituents by active weight

	Country	Sector	Weight (%)	Active weight (%)	ESG rating
ROCHE HOLDING GENUSS	SWITZERLAND	Health Care	2.96	2.39	A
INTEL CORP	USA	Information Technology	2.96	2.37	A
CHINA CONSTRUCTION BK H	CHINA	Financials	1.90	1.70	BBB
INTUIT	USA	Information Technology	1.54	1.39	AA
BIOGEN	USA	Health Care	1.50	1.36	A
ACCENTURE A	USA	Information Technology	1.48	1.22	AAA
RIO TINTO PLC (GB)	UNITED KINGDOM	Materials	1.34	1.21	A
TARGET CORP	USA	Consumer Discretionary	1.22	1.10	A
MICRON TECHNOLOGY	USA	Information Technology	1.19	1.08	BBB
CHINA MOBILE	CHINA	Communication Services	1.18	1.06	BB
PROGRESSIVE CORP	USA	Financials	1.11	1.00	BBB
BAXTER INTERNATIONAL	USA	Health Care	1.01	0.91	BB
AON PLC A	USA	Financials	1.00	0.90	BB
DOLLAR GENERAL CORP	USA	Consumer Discretionary	1.00	0.90	B
SK HYNIX	KOREA	Information Technology	0.96	0.87	BB
KONINKLIJKE PHILIPS	NETHERLANDS	Health Care	0.94	0.85	A
WALGREENS BOOTS ALLIANCE	USA	Consumer Staples	0.90	0.82	BBB
BHP GROUP (GB)	UNITED KINGDOM	Materials	0.84	0.76	BBB
ROSS STORES	USA	Consumer Discretionary	0.82	0.74	BB
NTT CORP	JAPAN	Communication Services	0.79	0.71	A

As of Mar 31, 2020

MSCI ACWI DMF Index: bottom constituents by active weight

	Country	Sector	Weight (%)	Active weight (%)	ESG rating
MICROSOFT CORP	USA	Information Technology	0.27	-2.60	AAA
APPLE	USA	Information Technology	0.53	-2.31	A
AMAZON.COM	USA	Consumer Discretionary	0.00	-2.07	BB
FACEBOOK A	USA	Communication Services	0.00	-1.01	BBB
ALPHABET C	USA	Communication Services	0.00	-0.90	AA
ALPHABET A	USA	Communication Services	0.00	-0.88	AA
JOHNSON & JOHNSON	USA	Health Care	0.00	-0.87	BBB
ALIBABA GROUP HLDG ADR	CHINA	Consumer Discretionary	0.00	-0.85	BBB
NESTLE	SWITZERLAND	Consumer Staples	0.00	-0.77	AA
JPMORGAN CHASE & CO	USA	Financials	0.00	-0.71	BB
TENCENT HOLDINGS LI (CN)	CHINA	Communication Services	0.00	-0.71	BBB
VISA A	USA	Information Technology	0.00	-0.69	A
PROCTER & GAMBLE CO	USA	Consumer Staples	0.00	-0.69	AA
BERKSHIRE HATHAWAY B	USA	Financials	0.00	-0.60	BB
UNITEDHEALTH GROUP	USA	Health Care	0.00	-0.59	BB
TAIWAN SEMICONDUCTOR MFG	TAIWAN	Information Technology	0.00	-0.56	AA
VERIZON COMMUNICATIONS	USA	Communication Services	0.00	-0.56	BBB
MASTERCARD A	USA	Information Technology	0.00	-0.55	A
AT&T	USA	Communication Services	0.00	-0.54	BB
HOME DEPOT	USA	Consumer Discretionary	0.00	-0.51	AA

As of Mar 31, 2020

Conclusion

Given a strong growth in factor, ESG and thematic investing, as well as the development of indexes to capture them, institutional investors may benefit from standard tools and frameworks to assess whether an index meets its objectives along the dimensions of performance, exposure (e.g., factors, sectors, countries and ESG) and investability.

The goal of MSCI IndexMetrics is to address this need by providing a consistent analytical framework to evaluate index characteristics. IndexMetrics aims to help investors by providing a comprehensive risk-return view on indexes an understanding of the sources of the underlying exposures driving these risks and returns. Further, it sheds light on investability, a dimension that had often been overlooked in prior analyses.

Through its scalability and wide applicability, we hope MSCI IndexMetrics helps to bring transparency to benchmark evaluation and creates a needed standard measurement framework for index investing.

Appendix: Definition of Statistics used in the MSCI IndexMetrics Framework

Key Metrics

Total Return

The index return is calculated as follows:

$$R_{ann} = \left(\frac{P_{end\_date}}{P_{start\_date}}\right)^{365.25/T} - 1,$$

where P_t is the index level at time t, and T is the total number of calendar days between the start date and the end date.

For period returns that appear in the performance table, the following assumptions are used to determine the start date:

- Year-to-date (YTD) return is always calculated starting from the last weekday of the previous year. It is not annualized (i.e., $T = 365.25$ is assumed in the formula above).
- Start dates for 1-, 3-, 5- and 10-year return calculations are determined by subtracting the respective number of years from the end date using the last weekday of the month as the start date.

Total Risk

The annualized total risk is a measure of the index return dispersion. It is calculated by annualizing the standard deviation of monthly index returns:

$$\sigma_{ann} = \sqrt{\sum_{t=1}^{n} \frac{12 * (R_t - \bar{R})^2}{n-1}},$$

where R_i is the return of the index in month t, and $\bar{R}$ is the mean monthly index return over the period.

Return/Risk

Return over risk measures the risk-adjusted index return by expressing the index return per unit of total risk. It is calculated as the ratio of annualized total return and annualized total risk:

$$RR_{ann} = \frac{R_{ann}}{\sigma_{ann}}.$$

Sharpe Ratio

The Sharpe ratio measures how well the return of the index above the risk-free rate (excess return) compensates for the risk taken. It is defined as follows:

$$SR = \frac{R_{ann} - RFR_{ann}}{\sigma_{ann}},$$

where RFR_{ann} is the annualized risk-free rate return throughout the analysis period in the currency of the report.

Active Return

The active return measures the gain or loss of the index relative to its benchmark and is defined as follows:

$$R^A_{ann} = R^I_{ann} - R^B_{ann},$$

where R^I_{ann} is the annualized total return of the index and R^B_{ann} is the annualized total return of its benchmark.

Tracking Error

The tracking error (also called active risk) measures the dispersion of excess returns of an index relative to its benchmark. It is defined as follows:

$$TE_{ann} = \sqrt{\sum_{t=1}^{n} \frac{12 * \left(R^A_t - \overline{R^A}\right)^2}{n-1}}$$

where R^A_t is the monthly active return of the factor index relative to its benchmark in month t. It is calculated as follows:

$$R^A_t = R^P_t - R^B_t.$$

Information Ratio

The information ratio is defined as the ratio of active return and tracking error and measures how well the factor index return above the benchmark compensates for the deviation from that benchmark:

$$IR_{ann} = \frac{R^A_{ann}}{TE_{ann}}.$$

Historical Beta

Beta is a measure of the level of sensitivity of the index to its benchmark. It is calculated as follows:

$$\beta = \rho^{P,B} \times \frac{\sigma^P_{ann}}{\sigma^B_{ann}},$$

where $\rho^{P,B}$ is the correlation between the monthly returns of the factor index and its benchmark throughout the analysis period.

Turnover

Turnover measures the percentage change in the composition of an index at each index review. We present the one-way index turnover in the report. Let I be the union of index constituents pre- and post-rebalancing. The one-way turnover at the rebalancing date t is calculated as follows:

$$TO_t = \frac{1}{2} \times \sum_{i \in I} \left| \omega^{opening}_{i,t} - \omega^{closing}_{i,t-1} \right|,$$

where $\omega^{opening}_{i,t}$ is the opening weight (post rebalancing but based on the $t-1$ pricing) of constituent i, and $\omega^{closing}_{i,t-1}$ is its closing weight (pre rebalancing, also based on $t-1$ pricing). The reported turnover figure is annualized (e.g., if the index is reviewed every quarter, the average at-rebalancing one-way index turnover will be multiplied by 4).

Financial Ratios

Please refer to the index ratios section of the MSCI fundamental data methodology for calculation details.

ESG: Integration, Values and Norms

ESG Score

ESG Score indicates how well the index companies manage their most material ESG risks relative to sector peers. Scores range from 10 (best) to 0 (worst). It is calculated as a weighted average of constituent level ESG scores.

ESG Leaders (AAA-AA) (%)

The ESG Leaders statistic measures the exposure (sum of weights) of the index to companies with an ESG rating of AAA or AA (best-in-class relative to peers).

ESG Laggards (B-CCC) (%)

The ESG Laggards statistic measures the exposure (sum of weights) of the index to companies with an ESG rating of B or CCC (worst-in-class relative to peers).

ESG Trend Positive (%)

The ESG Trend Positive statistic measures the exposure (sum of weights) of the index to companies with a rating upgrade over the past year.

ESG Trend Negative (%)

The ESG Trend Negative statistic measures the exposure (sum of weights) of the index to companies with a rating downgrade over the past year.

Index ESG Rating

Letter rating equivalent of the following calculation:

ESG Score * (1 + ESG Trend Positive - ESG Trend Negative - ESG Laggards).

Environmental Pillar Score

The environmental pillar score indicates how well the index companies manage their most material environmental risks. Scores range from 10 (best) to 0 (worst). This metric is not industry-adjusted. It is calculated as a weighted average of constituent level environmental scores.

Social Pillar Score

The social pillar score indicates how well the index companies manage their most material social risks. Scores range from 10 (best) to 0 (worst). This metric is not industry-adjusted. It is calculated as a weighted average of constituent level social scores.

Governance Pillar Score

The governance pillar score indicates how well the index companies manage their most material governance risks. Scores range from 10 (best) to 0 (worst). This metric is not industry-adjusted. It is calculated as a weighted average of constituent level governance scores.

Board Independence (WTG AVG%)

The board independence statistic measures the weighted average of the constituent level percentage of independent board members.

Female Directors (WTG AVG%)

The female-directors statistic measures the weighted average of the constituent level percentage of female directors.

Deviation From One Share One Vote (%)

The deviation from one share one vote statistic measures the exposure (sum of weights) of the index to companies flagged for any of the multiple equity classes with differential voting rights, golden shares or limitations on voting rights.

Tobacco Involvement (%)

The tobacco involvement statistic measures the exposure (sum of weights) of the index to companies flagged for involvement in tobacco.

Civilian Firearms (%)

The civilian firearms statistic measures the exposure (sum of weights) of the index to civilian firearms producers.

Ties to Controversial Weapons (%)

The ties to controversial weapons statistic measures the exposure (sum of weights) of the index to companies with ties to controversial weapons.

Global Compact Compliance Violation (%)

The global compact compliance violation statistic measures the exposure (sum of weights) of the index to companies in violation of the UN Global Compact principles.

Red Flag Controversies (%)

The red flag controversies statistic measures the exposure (sum of weights) of the index to companies with environment-, governance-, customer-, human rights- or labor rights-related controversies that are assessed as "Very Severe."

Orange Flag Controversies (%)

The orange flag controversies statistic measures the exposure (sum of weights) of the index to companies with ongoing environment-, governance-, customer-, human rights- or labor rights-related controversies that are assessed as "severe" and indicate structural problems at the company.

ESG: Climate Change

Carbon Emissions (T CO2E/$M Invested)

The carbon emissions statistic is a normalized measure for index carbon emissions. It is expressed in tons of CO2 per million USD invested.

Carbon Intensity (T CO2E/$M Sales)

The carbon intensity statistic measures the index efficiency in terms of total carbon emissions divided by total sales. It is expressed in tons of CO2 per million USD of sales.

Weighted Average Carbon Intensity (T CO2E/$M Sales)

The weighted average carbon intensity statistic measures exposure to carbon-intensive companies. It is expressed in tons of CO2 per million USD of sales.

Low Carbon Transition Score

The low carbon transition (LCT) score statistic measures the companies' level of alignment to the LCT at the index level.

It is calculated as a weighted average of constituent level LCT scores.

Solutions (%)

The solutions statistic measures the exposure (sum of weights) of the index to companies involved in low- or zero-carbon solutions that would have negative total carbon intensity.

Product and Operational Transition (%)

The product and operational transition statistic measures the exposure (sum of weights) of the index to companies with moderately to highly carbon-intensive products or operations.

Asset Stranding (%)

The asset stranding statistic measures the exposure (sum of weights) of the index to companies with very high exposure to transition risk that may face asset stranding risk in the short to medium term.

Potential Carbon Emissions (T CO2E/$M INVESTED)

The potential carbon emissions statistic is a normalized measure for potential carbon emissions of the index. It is expressed in tons of CO2 per million USD invested.

Thermal Coal Mining (%)

The thermal coal mining statistic measures the exposure (sum of weights) of the index to companies that derive some of their revenue from thermal coal mining.

Thermal Coal-Based Power Generation (%)

The thermal coal-based power generation statistic measures the exposure (sum of weights) of the index to companies that derive some of their revenue from thermal coal-based power generation.

Unconventional Oil & Gas Extraction (%)

The unconventional oil and gas extraction statistic measures the exposure (sum of weights) of the index to companies that derive revenues from unconventional oil and gas, including oil sands, oil shale, shale gas, shale oil, coal seam gas and coal bed methane. It excludes all types of conventional oil and gas production.

Clean Technologies Solutions (> 20% REVENUE)

The clean technologies solutions statistic measures the exposure (sum of weights) of the index to companies that derive 20% or more revenue from any of the five cleantech themes: alternative energy, energy efficiency, green building, pollution prevention or sustainable water.

Clean Technologies Solutions Revenue (WTD AVG %)

The clean technologies solutions revenue statistic measures the weighted average % revenue derived from any of the five cleantech themes, including alternative energy, energy efficiency, green building, pollution prevention or sustainable water.

Green/Brown Net Revenue Exposure

The green/brown net revenue exposure statistic measures the ratio of the weighted average clean technologies solutions revenue (%) or "green revenue" to the weighted average fossil fuel revenue (%) or "brown revenue," which is defined as the weighted average % revenue derived from any of the fossil-fuel-related activities, including thermal coal mining, oil and gas extraction, thermal coal-based power generation and oil and gas-based power generation.

Exposure to Carbon-Related Assets (%)

The exposure to carbon-related assets (%) statistic measures the exposure (sum of weights) of the index to companies that belong to the following GICS industries: energy equipment and services (101010), oil, gas and consumable fuels (101020), electric utilities (551010), gas utilities (551020) and multi-utilities (551030).

Climate-Related Controversies (%, Score ≤ 4)

The climate-related controversies statistic measures the exposure (sum of weights) of the index to companies with climate change and energy-related controversies that are flagged as red, orange and yellow and cover scores from 0 to 4.

Low Carbon Transition Management Score (% Top Quartile)

The low carbon transition management score statistic measures the exposure (sum of weights) of the index to companies that belong to the top quartile in terms of their low carbon transition management score relative to companies in the relevant GICS sub-industry that are constituents of the MSCI ACWI IMI.

Risk Profile

Total Risk

Refer to the definition of total risk in the key metrics section above.

Annualized Downside Deviation

The downside deviation takes into consideration only the volatility of negative returns. It is calculated as follows:

$$\sigma_{ann}^{d} = \sqrt{\sum_{t=1}^{n} \frac{12 * \left(R_t^d - \overline{R^d}\right)^2}{n-1}},$$

where $R_t^d = \min(R_t, 0)$.

Note that the numerator in the calculation of the lower semi-variance only includes returns less than zero. The denominator includes the total number of observations, as in the case for variance, which ensures that the sum of the lower and upper semi-variance is the (sample) variance.

Sortino Ratio

Sortino ratio is a modification of the Sharpe ratio that penalizes only those returns falling below a certain target (called minimum acceptable return). For IndexMetrics, we set this target to 0. Hence, the Sortino ratio is calculated as follows:

$$S_{ann} = \frac{R_{ann}}{\sigma_{ann}^{d}}.$$

Value at Risk (VAR)

Value at Risk is a measure of the risk of loss. For a given confidence level α, it is reported as the $1-\alpha$ percentile of historical monthly returns of an index. For example, a historical VaR of an index of -8% at the 95% confidence level means that that index had a loss greater than 8% on 5% of the months.

Expected Shortfall (CVAR)

Expected shortfall (also called conditional VaR) is defined as the mean of all losses that are greater than or equal to the VaR. Building on the previous VaR example, a historical CVaR of an index of -12% at the 95% confidence level means that the average loss of the index below -8%, with its VaR at 95%, was 12%.

Maximum Drawdown

The drawdown is a measure of the decline of an index from its peak. The maximum drawdown is its maximum over the full period of analysis. In other words, it is the largest peak to trough decline of the index. More formally, it is defined as follows:

$$\max_{\tau\in[1,n]}\left(\max_{t\epsilon[\tau,n]}-\left(\frac{P(t)}{P(\tau)}-1\right)\right).$$

Maximum Drawdown Period

Maximum drawdown period measures the duration of the maximum drawdown. It is expressed in months.

Skewness

Skewness is a measure of the asymmetry of the historical index return distribution. It is calculated as its third central moment based on monthly returns.

Kurtosis

Kurtosis is a measure of the sharpness of the peak of the historical index return distribution. It is calculated as its fourth central moment based on monthly returns.

Tracking Error

Refer to the definition of tracking risk in the key metrics section above.

Maximum Drawdown of Active Returns

Maximum drawdown of active returns measures the largest decline of the factor index relative to its benchmark.

Maximum Drawdown of Active Returns Period

Maximum drawdown of active returns period measures the duration of the maximum drawdown of active returns. It is expressed in months.

Capacity and Concentration

Average Number of Constituents

Monthly average number of index constituents

Effective Number of Constituents

The effective number of constituents is a measure of index concentration and ranges between 1 (weight of the index concentrated in a single stock) and n, (the total number of constituents of the index). Everything else being equal, a low effective number of constituents can be interpreted as a high concentration of the index. It is calculated as the inverse of the Herfindahl-Hirschman Index (HHI):

$$EN = \frac{1}{\sum_{i \in I} \omega_i^2},$$

where I is the set of index constituents, and ω_i is the weight of constituent i.

Parent Index Coverage

The market capitalization coverage measures the weight overlap of the factor index with its benchmark:

$$MC = \sum_{i \in I} \omega_i^B,$$

where I is the set of the factor index constituents, and ω_i^B is the weight of constituent i in the benchmark.

Top-Ten Constituents Weight

The top-ten constituents weight is a measure of concentration. It is calculated as the sum of the weights of the ten largest constituents of the index.

Size Family Exposures

Sum of the weights of stocks belonging to the large-, mid-, small- or micro-cap size families based on the MSCI Global Investable Market Index Methodology

Stock Ownership

The stock ownership statistics provide a measure of the index capacity and employ an assumption for fund size: $FundSize$ (USD 10 billion by default). We define the theoretical ownership for each stock as follows:

$$SO_i = \frac{\omega_i \times FundSize}{MarketCap_i},$$

where i refers to an index constituent and $MarketCap_i$ to its (full or free float-adjusted) market capitalization. The stock ownership section displays various descriptive statistics (mean, 95th percentile, maximum) for the $\{SO_i | \ i \in I\}$ distribution, where I is the set of index constituents.

Active Share

The active share is a measure of active tilt of the factor index relative to its benchmark. It is defined as the distance between the factor index and its benchmark using the one-way turnover metric:

$$AS_t = \frac{1}{2} \times \sum_{i \in I} \left| \omega_{i,t}^P - \omega_{i,t}^B \right|,$$

where I is the union of the index constituents of the factor index and its benchmark.

Weight Multiplier

The weight multiplier is also a measure of index tilt. For a constituent i, it is defined as the ratio of its weight in the factor index and the benchmark:

$$WM_i = \frac{\omega_i^P}{\omega_i^B}.$$

Both the average and the maximum weight multipliers are then reported.

Liquidity and Cost of Replication

Weighted Average ATVR

The annualized traded value ratio (ATVR) provides a measure of liquidity for security. It is defined in the MSCI Global Investable Market Index methodology.

In the IndexMetrics report, we report the weighted average ATVR at the index level.

Days to Trade

The days to trade provides a measure of liquidity and corresponds to the number of days required to implement a change in the index. Its calculation uses two parameters:

- $FundSize$; the fund size (USD 10 billion by default)
- $TradingLimit$; the maximum percentage of a stock's daily volume allowed for implementation (20% by default)

We then define the dollar trading limit for each security as follows:

$$DTL_i = 1MATV_i \times \frac{TradingLimit}{250}.$$

The days to trade for a constituent i is then defined as follows:

$$DTD_i = \frac{\left|\omega_i^P - \omega_i^B\right| \times FundSize}{DTL_i},$$

where ω_i^P is the weight of constituent i in the index and $1MATV_i$ is its 1-month annualized trade value. We calculate the days to trade along several dimensions:

- Relative to the benchmark (rebalancing away from the benchmark to the factor index); In this case, ω_i^B represents the benchmark weight.
- For a periodic index review (rebalancing away from the pre- to post-rebalancing weights); In this case, ω_i^B represents the factor index weight pre-rebalancing.
- Relative to cash (rebalancing away from cash to the factor index); In this case, ω_i^B is assumed to be 0 for every constituent.

For each of these $\{DTD_i | \ i \in I\}$ distributions, the weighted average, the 95th percentile and the maximum are then reported.

Days to Complete 95% of Trading Volume

This metric measures the number of days needed to complete 95% of trading volume. To calculate this, we first define the percentage of completed trading volume as a function of the number of days:

$$PCT(d) = \frac{\sum_{i \in I} min\left(DTL_i \times d,\ \left|\omega_i^P - \omega_i^B\right| \times FundSize\right)}{\sum_{i \in I} \left|\omega_i^P - \omega_i^B\right| \times FundSize}.$$

The days to complete 95% of the trading volume is then the value of d that minimized $|PCT(d) - .95|$.

Turnover

Refer to the section on the key metrics.

Performance Drag

The performance drag measures the approximate impact of an index review on performance, assuming different fixed trading costs. It is calculated by multiplying the one-way index turnover by two and the trading cost assumption (25, 50 and 75 bps).

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