

Sustainable Development Investing

Creating a scalable
SDI-aligned index

About the GISD Alliance

The Global Investors for Sustainable Development (GISD) Alliance is a group of 30 of the world's top business leaders convened by the United Nations Secretary-General to arrive at solutions that facilitate the scaling up of finance and investment necessary to achieve the Sustainable Development Goals (SDGs). Adopted by all UN Member States in 2015, the SDGs provide a road map for tackling climate change, ending poverty, improving healthcare and education, preserving the environment, and spurring economic growth.

The UN and GISD recognize that the SDGs cannot be reached without moving capital toward sustainable development. GISD members are leading by example, working to mobilize additional resources for countries and sectors most in need and to align business operations and practices with the SDGs. Since its inception in October 2019, GISD's members have worked with the UN and other partners to deliver sustainable development financing standards, tools, and products to unlock long-term investment in sustainable development.

Sustainable Development Investing:

Creating a scalable SDI-aligned index

Alexander Bassen¹, Christian Fieberg², Othar Kordsachia³, Kerstin Lopatta⁴, Bastian Nendza⁵

Commissioned by the Financing for Sustainable Development Office (FSDO) of the United Nations, in its capacity as Secretariat of the Global Investors for Sustainable Development (GISD) Alliance, the objective of this paper is to support the implementation of GISD's SDI definition by investors. The paper seeks to answer the following question: "How could a scalable market index be created using the Sustainable Development Investing (SDI) definition?" SDI refers to "deploying capital in ways that make a positive contribution to sustainable development, using the Sustainable Development Goals (SDGs) as a basis for measurement" (GISD, 2020a, p. 2).

We are thankful for the provision of data by Arabesque, Asset Owner Platform, FTSE, EIRIS, ISS ESG, MSCI, Refinitiv, Sustainalytics, and Vigeo Eiris.

The views expressed in this report do not necessarily reflect the views of any departments, organizations, agencies or programmes of the United Nations.

1 University of Hamburg, Department of Socioeconomics, Capital Markets and Management, Germany, e-mail: alexander.bassen@uni-hamburg.de. Hong Kong Baptist University, Department of Accountancy and Law, School of Business, Hong Kong.

2 University of Bremen, Faculty of Business Studies and Economics, Empirical Capital Market Research and Derivatives, Germany, e-mail: cfieberg@uni-bremen.de. Visiting Researcher at the University of Hamburg (Germany), Concordia University (Montreal, Canada), and University of Luxembourg (Luxembourg).

3 University of Hamburg, Department of Socioeconomics, Capital Markets and Management, Germany, e-mail: othar.kordsachia@uni-hamburg.de.

4 University of Hamburg, Department of Socioeconomics, Capital Markets and Management, Germany, e-mail: kerstin.lopat-ta@uni-hamburg.de. City University of Hong Kong, Department of Accountancy, Hong Kong

5 University of Hamburg, Department of Socioeconomics, Capital Markets and Management, Germany, e-mail: bastian.nendza@uni-hamburg.de.

1. Introduction

Commissioned by the Financing for Sustainable Development Office (FSDO) of the United Nations, in its capacity as Secretariat of the Global Investors for Sustainable Development (GISD) Alliance, the objective of this paper is to support the implementation of GISD's SDI definition by investors. The paper seeks to answer the following question: "How could a scalable market index be created using the Sustainable Development Investing (SDI) definition?" SDI refers to "deploying capital in ways that make a positive contribution to sustainable development, using the Sustainable Development Goals (SDGs) as a basis for measurement" (GISD, 2020a, p. 2).

To address this question, we describe in section 2 the practice of impact investing in public equity markets. There, we also examine the characteristics of selected existing SDG-related indices. Against this background, section 3 discusses how SDI can be operationalized by reviewing the availability of relevant firm-level data. In alignment to the SDI definition, our review of major commercial data providers shows that companies' SDG contribution can be measured on two levels: SDG contribution through products and services and SDG contribution through sustainable business conduct. SDG ratings for products and services were recently developed in response to the publication of the UN SDGs. Environmental, Social and Governance (ESG) ratings for companies' sustainable business conduct, also referred to as Corporate Social Responsibility (CSR), were developed much earlier. We further provide an overview of the data environment and identify challenges and data gaps for operationalizing SDI. On this basis, section 4 outlines our methodology for the development of an SDI-aligned market index. Our results indicate that such an index has similar risk-return characteristics to a traditional market index. Meanwhile, the constituents of the SDI-aligned index contribute more to the achievement of the SDGs through their products and services as well as through their sustainable business practices.

2. Impact investing in public equity markets

In this section we discuss the general concept of impact investing, highlight the opportunities in public equity markets, and review the current practices of six selected SDG-related indices.

a. Opportunities for impact investing in public equity markets

The typology of sustainable investing according to Busch et al. (2021) differentiates between impact investing, ESG-screened investments, and ESG-managed investments as underlying concepts of sustainable investments. The main objective of ESG-screened (-managed) investments is to reduce (systematically reflect) environmental and social risks to corporate financial performance, whereas impact investments incorporate external social and environmental challenges and goals. According to their definition, investments are impact-aligned when addressing these goals and challenges and impact-generating when they contribute to transformations. The difference in the objective affects materiality, the general investment approach, and documentation.

According to the Global Impact Investing Network (GIIN), impact investing refers to “investments made with the intention to generate positive, measurable social and environmental impact alongside a financial return” (GIIN, 2020, p. 74). The objectives of impact investors can be classified as finance-first or impact-first, meaning that they may seek market rate returns that are comparable with risk-return profiles of classic investments, or alternatively may accept below-market rate returns in order to reach their impact investing objectives. 67% of the participants in the GIIN 2020 Impact Investor Survey indicate that they seek risk-adjusted market-rate returns, 18% expect below market returns close to the market rate, and 15% focus on capital preservation below the market return. According to Wettstein, Dey, Schaefers, and Bahlmann (2019), the impact investing movement is at a crossroad: either it will enter the mainstream but face the risk of impact washing, or it will remain in a niche when impact investing is reduced to its most extreme form ignoring financial aspects. The participants of the GIIN 2020 Impact Investor Survey agree that impact washing is the greatest challenge by far: 66% expect impact washing to become one of the three greatest challenge in the next five years (GIIN, 2020). Most impact investors use a wide range of

impact investing frameworks and systems, although, according to the GIIN Impact Investor Survey 2020, the SDGs have been established as the most frequently used framework to, e.g., set impact objectives or measure or report on impact performance. The size of the impact investing market is currently estimated at USD 715 billion and is expected to grow steadily (GIIN, 2020).

However, the shortfall of investment capital of USD 2.5 trillion per year required to meet the SDGs by 2030 (UN, 2019) shows that impact investing in public equity is of particular importance when incorporating average deal sizes and investment potential across asset classes. The global private equity market comprises only USD 4.5 trillion (McKinsey, 2021), whereas the public equity market comprises USD 95.0 trillion (sifma, 2020). BlackRock (2020) claims that impact investing through public equity can democratize impact investing and exploit new investment pockets.

b. Selected approaches of impact indices

Equity indices aim to measure the performance of a basket of stocks and are constructed by relying on a standardized methodology based on quantitative measures. Indices represent and track the performance of a market area, traditionally characterized by regions, industries, and/ or securities' specifications. These equity bundles are used as benchmarks to evaluate investment performance or for low-cost passive indexing strategies that in turn make indices investable. Funds with a focus on ESG aspects have exhibited a competitive risk-adjusted performance in recent years and gained a remarkable increase in fund volume (Morningstar, 2021b). However, impact/ SDG-related funds and indices lag behind although interest in and demand for impact equity indices is increasing. To the best of our knowledge, there is currently just one SDG-related index that is replicated in the retail ETF market and backed by a noteworthy fund volume. The iShares MSCI Global Impact ETF, based on the MSCI Sustainable Impact Index, comprised nearly USD 500 million in net assets as of 9 June 2021⁶. In order to gain insight into the applied construction approaches of current SDG-related indices, we review six different indices:

- » MSCI Sustainable Impact Index (MSCI Index)⁷
- » Morningstar Societal Development Index (Morningstar Index)⁸
- » Solactive ISS SDG Aligned Global Markets All Cap Index (Solactive Aligned Index)⁹
- » Solactive ISS SDG Leaders Index (Solactive Leaders Index)¹⁰
- » Solactive Global UN Sustainable Development Goals Index (Solactive Global Index)¹¹
- » BNP Paribas Equity Global Goals World Strategy (BNP Index)¹²

6 See <https://www.ishares.com/ch/qualifizierte-investoren/de/produkte/283378/ishares-msci-global-impact-etf>

7 MSCI (2017), MSCI (2021a)

8 Morningstar (2021a), Morningstar (2021d)

9 Solactive (2020a), Solactive (2021b)

10 Solactive (2020b), Solactive (2021c)

11 Solactive (2020c), Solactive (2021a)

12 BNP (2019), BNP (2021)

Table 1: Selected SDG-related indices - Construction and composition

This table illustrates the final composition of six selected SDG-related indices and which asset selection and weighting approaches are used within the construction process. We differentiate screenings based on their underlying criteria. For products/services screening we differentiate whether a positive (+) or negative screening (-) is applied on an aggregated company level and/ or on all objectives/ SDGs individually. Screening thresholds are not provided in this table. The largest industry weights are based on index sponsors classifications when provided, otherwise indicated with n/a. All information is based on factsheets and methodology documents as of 30.06.2021.

	MSCI ACWI Sustainable Impact	Morningstar Societal Development Index	Solactive ISS SDG Aligned Index	Solactive ISS SDG Leaders Index	Solactive Global UN SDG Index	BNP Paribas Equity Global Goals
Construction						
Selection: screening						
- Products/Services (SDG Related)	Company level (+)	X	Company level (-) Objective level (-)	Company level (+) Objective level (-)	Company level (+) SDG level (-)	X
- Business involvement	✓	✓	✓	✓	✓	✓
- Controversies	✓	✓	✓	✓	✓	✓
- International norms	X	✓	✓	✓	✓	X
- ESG	✓	✓	X	X	✓	✓
- Financial metrics	X	X	X	X	X	✓
Selection: best-in-class	X	Top200 Societal Dev. Score	X	X	Top80 Div. Yield →Low20 volatility	X
Main data base	MSCI	Sustainalytics	ISS	ISS	ISS	Vigeo Eiris
Weighting	Adj. impact sales (\$)	Free-float market cap	Free-float market cap	Equally	Optimization (Minimum Variance)	Optimization (Best ESG Firms)
Additional weight constraints	Sector/issuer	Region/sector	X	X	Issuer	Tracking/issuer/ region/sector
Composition						
Number of assets	143	202	1,596	59	21	116
Largest weights	Tesla 4.5% Vestas 4.0% Umicore 3.9%	Nestle 5.1% TSMC 4.9% JP Morgan 4.7%	Apple 6.2% Microsoft 5.7% TSMC 1.4%	Sonova 2.1% Biogen 2.1% First Solar 2.1%	Great West 7.5% MTB 7.0% Merck & Co 7.0%	Nike 1.2% AMD 1.2% Ajinomoto Co 1.1%
Largest industry weights	Automobile 11.1% Pharma 10.7% Foods & Meats 10.7%	Technology 25.1% Financial Svcs 23.3% Healthcare 13.1%	n/a	n/a	n/a	Financials 20.3% Industrials 14.6% Consumer Gds 13.2%
Largest country weights	United States 26.4% China 13.6% Japan 12.8%	United States 52.6% Switzerland 8.6% Taiwan 6.1%	United States 57.7% Japan 4.6% United Kingdom 4.3%	United States 20.3% France 14.8% Germany 10.5%	Canada 32.2% Hong Kong 19.8% Singapore 9.1%	United States 50.6% France 11.9% Japan 11.3%

Based on factsheets, methodology documents/ rulebooks, and index sponsors' websites, we examine how constituents are selected and weighted, what datasets are used, and explore reconstitution practices and final characteristics, all summarized in table 1. In the asset selection stage, we differentiate between screening metrics that address companies' products/ services, sustainable business practices, and financial robustness.

Asset selection – Screening vs. best-in-class

At the baseline, the index sponsor has to decide whether to integrate screenings and/ or a best-in-class approach. Screenings ensure that selected assets meet minimum standards across multiple criteria but will lead to changes in the number of constituents at reconstitution dates. A best-in-class approach, which can be applied after possible screenings, leads to a fixed number of constituents over time but may be inappropriate if the implicit selection threshold becomes unreasonable.

The MSCI Index, Solactive Aligned Index, Solactive Leaders Index, and BNP Index use screenings, leading to a final number of constituents of 142, 1,596, 59, and 118, respectively. The number of constituents relative to the parent index indicate the rigorousness of the selection metrics. However, it should be noted that the exclusion rate may be driven by a single metric. The Solactive Global Index and Morningstar Index use screenings and a subsequent best-in-class approach, limiting the number of assets considered in the Solactive Global Index to 20 and the number of issuers considered in the Morningstar Index to 200.

Screening – Products/ services and controversial business involvement

A basic approach is to exclude companies that are involved in controversial business through their products and services. For the screening on products/ services, both the BNP Index and the Morningstar Index only use a negative screening based on a superior level of product classification. The BNP Index excludes firms with strong involvement in alcohol, civilian firearms/ military, gambling, nuclear power, pornography, or tobacco or are active in the production/ extraction of tar sands, oil shale, or coal to the tune of more than 10% of total revenue.

Likewise, the Solactive Aligned Index only focuses on negative product screening. It screens companies for involvement in controversial weapons but additionally uses an SDG impact screening based on a dataset that granularly clusters products to assess the impact on the

SDGs in terms of associated revenue¹³. The latter excludes companies with a negative impact at an aggregated SDG level and/or a significant negative impact on any single SDG.

The Solactive Leaders Index uses the same data basis with the same selection criteria but with different thresholds to integrate a positive screening. It selects firms that have a significant positive impact on an aggregated SDG level and no negative impact on any single SDG. After the whole selection process including other metrics, the Solactive Leaders Index only comprises 59 assets. By contrast, the Solactive Aligned Index incorporates 1,596 assets having the same selection process only varying on selection thresholds for the product screening, as indicated previously.

To be selected for the MSCI Index, companies must generate cumulatively at least 50% of their revenues from sustainable products. The underlying database also clusters products on a granular level, but only focuses on positive contribution towards the SDGs. Therefore, the MSCI Index additionally uses a basic negative screening based on any involvement in alcohol, tobacco, predatory lending, controversial weapons, nuclear weapons, conventional weapons, and civilian firearms based on different involvement levels.

Screening – Sustainable business practices

The consideration of ESG ratings and ESG controversies has been established as a standard to screen for sustainable business practices. Here, the main objective is to exclude firms with poor ESG standards rather than selecting firms with the highest ESG standards. The MSCI Index, Morningstar Index, Solactive Global Index and BNP Index all integrate an ESG rating in their methodology based on aggregated ESG scores. The MSCI Index excludes ESG rating laggards (lower than BB on a credit rating scale). Alongside an internal ESG score, BNP requires firms to be in the top two thirds of the external ESG ranking in their sector and to have an ESG score that is equal to or greater than 30 out of 100.

The Solactive Aligned Index and Solactive Leaders Index waive ESG ratings and solely integrate a controversy screening based on compliance with international norms on environment, human rights, corruption, and labor rights. The Morningstar Index and the Solactive Global Index also screen for compliance with the UN Global Compact but as a supplement to the general controversy screening. As the MSCI Index and BNP Index also incorporate a controversy screening, all selected indices use some sort of controversy screening. Typically, only firms with severe con-

¹³ Impact is rated on a scale from -10 to +10; significant negative impact (-10 to -5), negative impact (-5 to 0), neutral (0), positive impact (0 to +5) and significant positive impact (+5 to +10).

troveries are excluded; e.g., Morningstar excludes firms with controversies in business ethics, governance, public policy, employee relations, social supply chain, society and community, and/or operations and environmental supply chain that are rated 4 or higher on a five-point scale.

Screening – Financial robustness

Besides products/ services and ESG metrics, BNP also screens for financial metrics using an internal score that rates firms on seven criteria related to profitability, prospects, or valuation. The inclusion of financial criteria alongside impact criteria in the selection process can ensure at least a minimum financial performance but does carry the risk of excluding top SDG/ ESG performers.

Best-in-class

Morningstar selects the best 200 issuers based on their own Societal Development Score after screening for companies' controversial business involvement, compliance with the UN Global Compact, severe controversies, and ESG risks. The Societal Development Score is based on a weighted average of 32 indicators covering business ethics, employment practices, contractor and supply chain monitoring, community involvement and social development programs, and financial inclusion in access to products and services using individual materiality weights. To calculate the final score, the weighted average is adjusted by the revenue exposure in "low/ lower middle income" countries. Scaling factors are 1.125, 1.25, and 1.5 for a revenue exposure of more than 1%, 5%, and 10%, respectively. This unique approach is motivated by the idea of shifting capital to less developed countries.

After screening for products/ services, the ESG score, and compliance with the UN Global Compact, the Solactive Global Index uses a two-step best-in-class approach. First the Top 80 assets with the highest realized dividend yield are selected, followed by the final selection of the Top 20 assets with the lowest volatility.

Data basis

Generally, for index construction purposes index sponsors use preconceived scores and information gained from different datasets but usually provided by the same data provider. The focus on only one data provider is presumably due to cost efficiency, varying coverage, and matching problems, not necessarily because the individual datasets and scores are assessed as most appropriate. The Morningstar Index is by some means unique in this regard as it is based partly on an own Societal Development Score.

Reconstitution

The reconstitution of indices is usually executed quarterly or yearly taking the latest available ratings. A timelier reconstitution may ensure that current index constituents still meet the selection criteria considering the newest available information, on the other hand it increases maintenance effort and transaction costs when replicated. The MSCI Index and Morningstar Index include buffer rules for current constituents at reconstitution dates. MSCI allows current constituents that fail to meet the 50% impact revenue threshold to stay in the index if they have more than 40% impact revenues while still meeting all other selection metrics.

Asset weighting

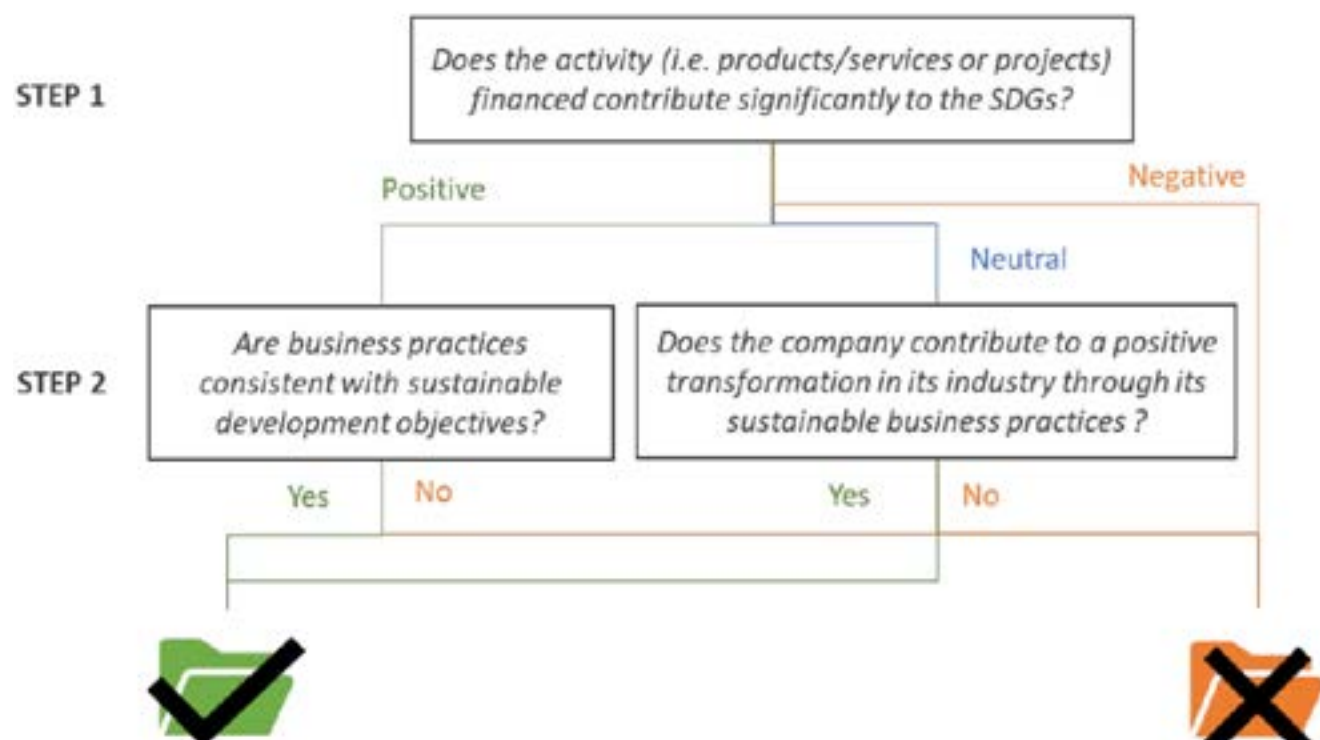
The Morningstar Index and Solactive Aligned Index use a value weighted approach based on free-float market cap, whereas the Solactive Leaders Index weights selected constituents equally. The Solactive Global Index with only 20 constituents uses a minimum variance optimization technique to reduce its volatility. In contrast to these classical weighting approaches, SDG-related indices may also consider impact metrics in this construction step. The MSCI Index weights assets based on adjusted absolute annual revenues of sustainable products¹⁴ with sector weights capped at 20% and issuer weights capped at 4%. BNP uses a mathematical optimization algorithm to maximize the aggregate weight of selected firms identified as “SDG Champions,” with optimization constraints regarding issuer weights (< 1%), risk (< 3% expected tracking error) and sector/geographic exposure (compared to a benchmark). SDG Champions are leaders in sustainable products, practices, or progression in their sectors and regions while meeting increased ESG score thresholds. Based on the selection criteria, number of constituents and the general weighting approach, unintended cluster and concentration risks may arise. It may be reasonable to consider additional weighting constraints to limit the exposure to certain industries, countries, or individual issuers, as applied by some of the selected indices. On the other hand, specific exposures may be desirable to track a specific market area.

¹⁴ The revenue is multiplied with the ratio of free-float adjusted market capitalization of the asset to total market capitalization of the issuer.

3. Operationalizing sustainable development investing

Aligning investments with the definition of SDI requires that deployed capital make a positive contribution to sustainable development, using the SDGs as a basis for measurement. Operationalizing this definition thus requires that investors assess the SDG contribution of investee companies. However, this is a very challenging task. First, any contribution to the 17 SDGs and their 169 targets is not easily measurable on the corporate level. The classification of products and services is necessary to address the first step of the SDI decision tree (GISD, 2020a), which is depicted in figure 1. What are the products and services that significantly contribute to one or more SDGs?

Figure 1: GISD (2020a) SDI decision tree



In the absence of a public and universally applicable and economy-wide taxonomy of all products and services with their respective contribution to the SDGs, answering this question is difficult. Secondly, the complexity of publicly listed companies means that their products, services, and operations can contribute to some of the SDGs while also obstructing others. Estimating the net effect of potential investees on SDG achievement requires a comprehensive analysis across various economic activities while also considering general business practices (e.g., stakeholder engagement, sustainable corporate governance, sustainable supply chains, etc.). The assessment of general business practices is the focus of the second step of the SDI decision tree. Table A1 shows recent methodologies, which combine the assessment of SDG alignment based on products and services and general business conduct into a single composite rating. The following sub-sections describe both components and the respective rating approaches in more detail.

a. Corporate SDG contribution through products and services

This section presents an overview of different taxonomies for measuring corporate SDG contribution through products and services. Only companies that make a positive or neutral contribution to the SDGs may advance to the second step of the SDI decision tree. Several institutions provide general guidance for the assessment of products and services. For example, the “Impact Investing Market Map” published by the UN PRI (2018) links ten environmental and social themes along which businesses can contribute to the SDGs. The World Benchmarking Alliance (2019) is currently developing benchmarks across seven system transformations¹⁵ for achieving the SDGs for 2,000 keystone companies. These are expected to be published by 2023 and could be a valuable resource for investors when selecting companies that contribute to the transformation of the global economy towards more sustainability. The “SDG Compass”, jointly developed by the Global Reporting Initiative (GRI), UN Global Compact, and the World Business Council for Sustainable Development, provides an inventory of business indicators¹⁶ which are meaningful for the SDGs.

Despite such guidance, measuring SDG contribution through products and services of individual companies remains very challenging. In our case, we need to assess and rank many companies to select the constituents of an investable SDG-aligned equity index. Doing this on an ongoing, case-by-case basis is not feasible. Therefore, we turn to commercial solutions for the measurement of companies’ SDG contribution that were recently developed by major data providers. Table A2 provides an overview of selected commercial solutions including a brief description

¹⁵ Social transformation, agriculture and food system transformation, decarbonization and energy transformation, circular transformation, digital transformation, urban transformation, financial system transformation

¹⁶ Available online: <https://sdgcompass.org/business-indicators/>

of the respective methodologies. To conduct this research, we reached out to each of the listed data providers and were able to get additional insights into their approach towards measuring individual companies' SDG contributions. This section provides a general overview of selected products, while section 4 discusses our selection of specific data providers for constructing the hypothetical SDI-aligned index.

As can be seen from table A2, consistent with the first step of the SDI decision tree, the different rating methodologies consider the contribution of products and services to the SDGs as the primary measurement unit. The net contribution of various products and services is commonly calculated through revenue-based weighting. While some data providers also consider negative impacts of economic activities (e.g., SDG Solutions Assessment by ISS ESG), others only report revenues that are in alignment with their underlying taxonomy (e.g., Green Revenues by FTSE ESG). The latter is consistent with the disclosure format of revenues that are in alignment with the EU Taxonomy Regulation, which requires that companies only have to disclose the financial KPIs that meet the respective technical threshold. However, investors receive no additional information about the revenues obstructing the attainment of the six sustainability objectives that are described in the regulation. When it comes to SDG contribution, it is reasonable to assess both the positive and negative impact of economic activities.

Our review of the different rating methodologies further shows that the transfer of the SDGs to a firm-level analysis is often done via certain sustainability objectives or themes. Several SDGs may be mapped to one or multiple objectives. For example, the ISS ESG SDG Solutions Assessment maps SDG 3 (good health and well-being) and SDG 6 (clean water and sanitation) to the sustainability objective "ensuring health." The ISS SDG Solutions Assessment is based on a total of 15 sustainability objectives, which are divided into seven social objectives and eight environmental objectives. Similar categories are also applied by Vigeo Eiris and others.

b. Corporate SDG contribution through sustainable business practices

Companies may contribute to the SDGs not only through their products and services, but also through their general business practices. Even when companies' products and services significantly contribute to the SDGs, following the second step of the SDI decision tree, sustainable development investors need to consider the business practices of potential investees. The academic literature on business ethics, sustainable finance, and sustainability accounting uses ESG ratings to measure sustainable business practices, generally referred to as CSR (Chen, Dong, & Lin, 2020; Gillan, Koch, & Starks, 2021; Liang & Renneboog, 2017; Lins, Servaes, & Tamayo, 2017;

van Duuren, Plantinga, & Scholtens, 2016). Table A3 provides an overview of major ESG rating providers. Because ESG ratings are not derived from the same underlying indicators and methodologies, individual companies may be evaluated differently (Berg, Koelbel, & Rigobon, 2020; Chatterji, Durand, Levine, & Touboul, 2016; Dorfleitner, Halbritter, & Nguyen, 2015). Despite these differences, investors may use ESG ratings when selecting investments for sustainable development. More work is necessary to identify ESG indicators or benchmarks for publicly listed companies that are most central to the SDGs. In this context, media-based ESG controversy ratings and principle/ norm screenings (see table A4 for an overview) can supplement traditional ESG ratings. Depending on the methodology, significant controversies are not necessarily reflected in ESG ratings that are primarily derived from company disclosures.

c. Comparison between SDG ratings (classification of products/ services) and ESG ratings (classification of business practices/ CSR)

Traditional ESG ratings are not specifically intended or designed to measure the contribution of companies to the SDGs. In most cases, rating methodologies were developed well before the UN published its Sustainable Development Agenda. For example, Refinitiv ESG ratings date back to 2002. While the measurement of companies' ESG performance has evolved over time, and while there are also substantial differences between different data providers in terms of the individual indicators that are included in the composite ESG ratings, there are nonetheless, significant conceptual differences between the assessment of companies' ESG performance and companies' SDG contribution. These differences are illustrated in table 2.

Industry affiliation

The measurement of companies' SDG contribution is substantially determined by their industry affiliation generally, and by their output in terms of products and services, specifically (GISD, 2020a, 2020b). Due to industry characteristics and individual business models, companies may contribute only to a subset of the 17 SDGs and 169 targets. Very few companies can realistically contribute to the goal of "peace, justice, and strong institutions" (SDG 16), which may only be achieved by adequate public policy measures. That said, given their products and services, several publicly listed companies in the renewable energies sector contribute to the goal of "affordable and clean energy" (SDG 7). By contrast, ESG ratings are mostly indifferent to the industry affiliation of the rated companies. Companies in sensitive industries (e.g., tobacco, gambling, alcohol, and adult entertainment) may have higher ESG ratings than companies in the renewable energies sector (Garcia, Mendes-Da-Silva, & Orsato, 2017). In essence, the ratings of

traditional ESG data providers are substantially driven by the scope of companies' CSR disclosure compared to peer companies (i.e., best-in-class ratings) which, on the one hand, increases transparency for investors (Saadaoui & Soobaroyen, 2018) but on the other, raises concerns over strategic greenwashing practices (Laufer, 2003). Depending on the indicators that are included in the ratings, individual products may still have some relevance for the overall assessment of ESG performance. For example, the product innovation category score, one of the three category scores that make up Refinitiv's environmental pillar score,¹⁷ considers, for certain industries, the percentage of green products and services as reported by the company¹⁸ as an indicator. Even within the environmental dimension of ESG, ratings are to a greater extent defined by company disclosures that are not specific to individual products. For example, the disclosure of a policy to increase water efficiency¹⁹ receives a positive polarity by Refinitiv. Across the environmental, social, and governance dimension, 25 of the 186 indicators in Refinitiv's ESG scoring are related to company policies. Without a qualitative evaluation, simply having a policy may significantly improve a company's overall ESG rating, irrespective of the impact of its actual products and services. A similar logic holds for other ESG data providers. Approximately 50% of indicators that compose MSCI ESG ratings are based on voluntarily self-reported ESG information.²⁰ While ESG policies may have a real effect on nonfinancial outcomes and ESG related policies may also constitute an important signaling instrument, they can also be misused for greenwashing (Laufer, 2003) – a practice by companies to strategically improve ESG ratings through boilerplate disclosures. Despite this concern, because sustainable business practices of companies are difficult to assess for market participants, ESG disclosures by companies are still highly relevant for the evaluation of both ESG performance and SDG contribution. To mitigate the impact of favorable self-display by companies, investors should also assess whether media coverage about possible ESG controversies is consistent with information disclosed by companies (Dorfleitner, Kreuzer, & Sparrer, 2020).

Financial materiality

Many data providers consider the financial materiality of individual ESG indicators. Financial materiality may determine whether an indicator is included in the composite ESG rating and whether it receives some weighting adjustment as compared to other indicators (MSCI, 2021b; Refinitiv, 2021; Sustainalytics, 2021b). While the financial materiality of ESG indicators is therefore highly relevant for ESG ratings, this is not necessarily the case when assessing companies' SDG con-

17 The aggregate Refinitiv ESG Score consists of the environmental, social, and governance pillar scores. For more information, see: https://www.refinitiv.com/content/dam/marketing/en_us/documents/methodology/refinitiv-esg-scores-methodology.pdf

18 Eikon code: TR.RevenueEnvProducts

19 Eikon code: TR.PolicyWaterEfficiency

20 More information is available on their website: <https://www.msci.com/what-if-esg-disclosures-become-standardized>

tribution. The SDGs are a “universal call to action to end poverty, protect the planet and improve the lives and prospects of everyone, everywhere.”²¹ This broad objective does not depend on any considerations regarding the financial materiality of companies’ economic activities. Any economic activity that contributes to any of the SDGs counts towards the overall SDG contribution of a company, no matter the financial materiality of that activity for that specific company. Thus, the principle-based nature of the SDGs contrasts the outcome-oriented approach of traditional ESG assessments. Against this background, products and services that contribute to the SDGs should still be economically viable, so that companies are incentivized to produce such economic goods and are simultaneously able to meet their fiduciary duties to their shareholders.

Perspective of the analysis

In terms of the interconnections between companies and the environment, determining an SDG contribution is best analyzed through the lens of the inside-out perspective, meaning the spotlight is on the impact of the company on society and the planet. By contrast, determining ESG performance commonly takes the outside-in perspective, meaning that the evaluation of ESG indicators is influenced by the impact of external factors (e.g., regulatory changes, climate activism, changes in customer preferences, etc.) on the company.

Incorporation of financial and sustainability information

The quantification of ESG performance versus SDG contribution also differs as regards the type of information that is most relevant. Since SDG contribution is mostly assessed in terms of a company’s products and services, the breakdown of financial information (i.e., revenues from operations) is extremely relevant (ISS ESG, 2020). While some ESG indicators are also derived from financial information (e.g., accounting items like environmental provisions, expenditures, and fines), ESG indicators are mostly based on sustainability information from CSR reports. This means that ESG ratings factor in the transparency of companies’ CSR disclosure to a large extent (Refinitiv, 2021). While companies with high ESG ratings may also significantly contribute to the SDGs, this is not necessarily the case due to the conceptual differences described above. The next section takes a closer look at data availability to identify sustainable development investments.

21 Citation from the UN’s official website <https://www.un.org/sustainabledevelopment/development-agenda/>

Table 2: Conceptual differences between ESG ratings and SDG ratings

Rating companies' ESG performance through business practices	Rating companies' SDG contribution through products/services
Industry affiliation	
<i>Minor or no relevance.</i> Companies in sensitive industries (e.g., tobacco, gambling, alcohol, and adult entertainment) may have high ESG ratings. Industry-adjusted ratings are common.	<i>High relevance.</i> SDG contribution is highly dependent on companies' industry affiliation.
Products and services	
<i>Minor relevance.</i> Only a subset of ESG indicators relates to products and services.	<i>High relevance.</i> Products and services determine impact and contribution to the SDGs.
Business practices	
<i>High relevance.</i> Unethical business practices may result in public controversies which can have a negative impact on ESG ratings. The disclosure of a code of conduct and similar policies are common indicators that are included in ESG ratings.	<i>High relevance.</i> Unethical business practices can have a negative impact on SDG contribution.
Financial materiality	
<i>High relevance.</i> Several data providers consider financial materiality for the inclusion (and sometimes weighting) of indicators in ESG ratings.	<i>Low relevance.</i> Companies may contribute to SDGs, irrespective of financial materiality.
Perspective of the analysis	
<i>High relevance of the outside-in perspective.</i> ESG ratings generally consider indicators that can have an impact on the financial performance of the company.	<i>Low relevance of the outside-in-perspective.</i> SDG contribution is not determined by the financial materiality of external factors on companies.
<i>Low relevance of the inside-out perspective.</i> ESG ratings commonly consider companies' impact on society and the environment only to the extent that said impact is financially material.	<i>High relevance of the inside-out-perspective.</i> SDG contribution is measured in terms of the companies' impact on society and the environment.
Financial information	
<i>Some relevance.</i> A limited subset of indicators draws upon companies' financial information (e.g., environmental provisions, expenditures, and fines etc.).	<i>High relevance.</i> Companies' SDG contribution is predominantly determined by revenue generated from products and services.
Sustainability information	
<i>High relevance.</i> Many indicators are related to the disclosure of sustainability information (e.g., publication of a CSR report, alignment to the GRI, and external assurance of the CSR report etc.).	<i>High relevance.</i> Sustainability information relating to topics such as the diversity of the workforce, corporate carbon emissions, and sustainable supply chain management may impact companies' SDG contribution.

d. Reflection on the information environment: Data gaps and other challenges

Operationalizing the definition of sustainable development investing along the SDI decision tree requires the availability of relevant and reliable data. Based on our consultation with different data providers, internal discussions, and a review of the academic literature, we identify the following main challenges and data gaps for the development of SDG ratings for companies.

Revenues from products and services

Step one of the SDI decision tree assesses the contribution of economic activities to the SDGs. A positive assessment at this stage requires a significant contribution to the SDGs through products and services. The application on the company level therefore necessitates that institutional investors assess all products and services offered by potential investee companies. Annual reports provide some information about different business segments in which companies operate. Following the International Accounting Standard Board's strategy of convergence, the US Generally Accepted Accounting Principles (US GAAP) and the International Financial Reporting Standards (IFRS) put forth similar segment reporting requirements as per SFAS 131 and IFRS 8, respectively (Deloitte, 2006). The aggregation of economic activities to operating segments is based on similarities in terms of long-term financial performance and economic characteristics. According to SFAS 131 (paragraph 17), under certain conditions two or more operating segments may be aggregated into a single operating segment. Mandatory disclosure of operating segments is also subject to certain quantitative thresholds (SFAS 131 paragraph 18; IFRS 8 paragraph 13). Segment reporting provides relevant information to classify business segments as regards their contribution to the SDGs. However, due to the possible aggregation of multiple business segments, quantitative thresholds, and further managerial leeway over disclosure granularity, companies are not mandated to disclose financial information about all of their products and services to investors.

Aggregation of revenues from products and services

To assess a company's SDG contribution overall, investors need to aggregate all information about individual products and services to generate a single company rating. To this end, investors may assess some financial metrics associated with the company's economic activities. Similar to the approach described in article 8 of the EU Taxonomy Regulation (Regulation (EU) 2020/852), which outlines the financial KPIs for quantifying companies' EU Taxonomy alignment, investors may retrieve information about revenues from operating segment disclosure. Based on

technical screening criteria as disclosed in dedicated acts²², the EU Taxonomy Regulation sets out a taxonomy of environmentally sustainable economic activities. In a similar vein, regulators may publish a taxonomy of SDG-aligned economic activities that could inform investors about the SDG contribution of their investment. As of today, there are no initiatives by regulators to mandate a revenue breakdown of products and services showing their contribution to the SDGs. First disclosures in alignment with the EU Taxonomy Regulation will be published in 2022 for fiscal year 2021. While the information disclosed in accordance with article 8 of the Regulation may provide some information about the SDG contribution of European companies, corporate environmental sustainability only relates to a subset of the SDGs.

Revenues from geographic segments

Investments in sustainable development could be selected based on the countries in which potential investees produce and sell their products and services. According to IFRS 8 and SFAS 131, companies must disclose geographic segments based on materiality considerations. Therefore, equity investors may not have full information about all the countries in which an investee generates revenues. Many companies only report broad geographic regions instead of country specific segments (Cereola, Nichols, & Street, 2017).

Comparability of CSR reporting

While companies could use the SDGs as an overarching framework to communicate their strategies, objectives, and operations, references to the SDGs are currently not mandated by CSR disclosure regulations. However, companies may still choose to align their CSR activities and disclosures with the SDGs. Several voluntary frameworks²³ provide guidance in this regard. Yet companies have significant leeway over the extent to which they cover sustainable development topics in their disclosures and how they evaluate their own contribution to the goals. The low level of comparability of CSR reporting across geographies, industries, and individual firms substantially impairs investors' ability to integrate internal SDG alignment taxonomies in the investment process. Even when companies (voluntarily) report relevant KPIs, these are often difficult for users to find, and they are rarely available in a machine-readable digital format.²⁴

22 For more information, see the EU Commission's web page on the EU Taxonomy Regulation: https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/eu-taxonomy-sustainable-activities_en

23 E.g., the SDG Compass developed by GRI, the United Nations Global Compact, and wbcSD, or the SDG Industry Matrix developed by the United Nations Global Compact and KPMG. Moreover, ISO 26000 Guidance on Social Responsibility can be aligned to the SDGs. (see: ISO 26000 and the SDGs, available from <https://www.iso.org/files/live/sites/isoorg/files/store/en/PUB100401.pdf>)

24 The implementation of the EU's proposal for a Corporate Sustainability Reporting Directive (CSRD), revising Directive 2014/95/EU, would require companies to digitally "tag" the reported information to make it machine-readable.

SDG/ESG ratings by data providers

The quality and reliability of data providers' SDG/ ESG ratings substantially depend on the characteristics of company disclosures described above. For example, because companies can aggregate business and geographic segments in their annual reports, data providers can hardly assess the SDG contribution of all company products across countries. This is also true as regards disclosures on supply chains and production sites. Therefore, company ratings commonly necessitate that data providers estimate certain metrics, which introduces some uncertainty as regards the final assessments. Because SDG ratings based on products and services are relatively new or still under development,²⁵ these are not yet available for all publicly listed companies. While the coverage is larger, this is also true for traditional ESG ratings. Data providers usually extend their coverage starting with the largest companies (Refinitiv, 2021). As a consequence, as of now, fewer SDG/ ESG ratings are available for companies in developing countries. As an example, figure 2 illustrates the geographic coverage of Refinitiv ESG.

Figure 2: Geographic coverage of Refinitiv ESG



²⁵ For example, ESG Screen 17 (<https://www.screen17.com>) currently develops company ratings as regards all of the 17 SDGs.

4. Development of a proprietary SDI-aligned index

The previous section introduced various data providers that can be used to rate investees in terms of their contribution to the SDGs. Given access to all the company ratings described in section 3, we now assess their applicability to the GISD's definition of SDI. Moreover, this section describes the selection criteria of data providers and rating thresholds for index inclusion. This section also evaluates the performance of the index against the MSCI ACWI as the benchmark.

a. Selection of data providers

This subsection describes the data providers that we decide to examine in more detail. We perform no judgement of the quality of the data providers and their respective solutions.²⁶ While we believe that our choice of data providers and metrics is one possible solution for developing an SDG-aligned index, we should point out that other choices and approaches may be reasonable too. Our objective is to inform investors and index providers about one way to operationalize SDI by creating a broad and investable index with a multi-level objective function that includes risk, return, and the contribution to sustainable development. Our selection of suitable data providers is determined by several factors:

- » Applicability to the SDI decision tree
- » Number of companies included in the dataset (coverage)
- » Availability of historical values
- » Overlap in the coverage of different data providers
- » Transparency of the rating methodology

²⁶ We are thankful for the provision of data by Arabesque, Asset Owner Platform, FTSE, ISS ESG, MSCI, Refinitiv, Sustainalytics, and Vigeo Eiris.

Rating companies' products and services

ISS ESG SDG Solutions Assessment

To rate potential investee companies in terms of their contribution to the SDGs through their product and services, we use ISS ESG SDG Solutions Assessment (ISS SDG SA). This dataset has favorable features for our purposes. First, in alignment with the SDI decision tree, ratings can be positive, negative, and neutral. This allows us to specify evaluation criteria for the selection of index constituents, which also consider the possibility that companies with a neutral rating in the first step may be included in the index if they contribute to positive transformation in their industry through their sustainable business practices. Second, historical data is available for back-testing the performance of the SDI-aligned index. Third, the dataset includes a global sample of companies.

The ISS SDG SA universe is our starting point for creating the SDI-aligned index. The number of companies with a rating increases over time. Because this is a new dataset, the coverage is expected to further increase in future. However, it is already broad enough to construct the hypothetical index.

ISS SDG SA applies its own proprietary taxonomy for mapping products and services to the SDGs.²⁷ For each company, they produce ratings across 15 sustainability objectives aligned with the SDGs. The ratings range from “significant obstruction” to “significant contribution,” equaling numeric ratings from -10 to 10. For example, products with a high nutritional value like fruits and vegetables significantly contribute to the sustainability objective “Combating Hunger and Malnutrition,” which is linked to SDG 2 (Zero Hunger). Individual products and services may also contribute to more than one sustainability objective:

(...) the product category “organic-certified tobacco” can be assessed with “significant obstruction” under the “Ensuring health” objective due to its detrimental impacts on human health. At the same time, this exact same product category can be assessed with “significant contribution” under “Achieving sustainable agriculture and forestry”. (ISS ESG, 2020)

The objective scores are calculated by multiplying the estimated net sales share generated with relevant products and services with the numeric scores assigned to them. For each of the sus-

²⁷ For more detail, see their methodology document available here: <https://www.issgovernance.com/esg/impact-un-sdg/sustainability-solutions-assessment/>

tainability objectives, figure A1 illustrates the contribution and obstruction of rated companies across GICS industry groups. For the construction of the indices, we use indicator variables for firms' positive, negative, or neutral SDG contribution that are denoted as OS+, OS−, and OS•, respectively. For our analysis, we take the sum of the 15 objective ratings to create a single firm-level measure for total SDG contribution, denoted as ΣOS . All variables for the SDI index creation are defined in table 4.

Table 3 presents the correlations between the ratings of different data providers (ISS ESG, Entis/SDI AOP, MSCI, and FTSE), which assess companies' contribution to the SDGs based on their proprietary classification taxonomies of products and services. We find that our measure (ΣOS) based on ISS SDG SA, the one that we decided to use for the selection of index constituents, correlates positively and significantly with alternative rating providers. This means that the application of different ratings could result in a similar index constitution. The strongest correlation (0.562) is with the SDI measure developed by Entis. Some companies claim SDG contributions in their own CSR reports. Table 3 shows that such self-disclosed SDG contribution (the variable is denoted as *selfdisclosed_sdg*) correlates weakly and negatively with ΣOS . This reinforces the need for independent assessments/ audits of companies' products and services. Figure A2 shows binned scatterplots between the different ratings.

Table 3: Correlations between ratings for companies' products and services from different data providers

Iss_sdg is the sum of the 15 ISS SDG SA Objective Scores, also denoted as ΣOS . *Entis_sdg* is the percentage of revenues generated by sales of products that qualify for SDI as reported by Entis. *Msci_sdg* is the sum of the MSCI SDG Net Alignment Score across all 17 SDGs. *Ftse_gr* is the percentage of revenues generated by sales of green goods, products and services as determined by FTSE. *Selfdisclosed_sdg* is the number of SDGs to which the company claims to be contributing to in their own sustainability disclosures. This information is retrieved from Eikon. Depending on provided data, availability, and coverage, correlations are based on yearly firm ratings from 2016 to 2020.

Variables	<i>iss_sdg</i> (ΣOS)	<i>entis_sdg</i>	<i>msci_sdg</i>	<i>ftse_gr</i>	<i>selfdisclosed_sdg</i>
<i>iss_sdg</i> (ΣOS)	1.000				
<i>entis_sdg</i>	1.562***	1.000			
<i>msci_sdg</i>	0.375***	0.189***	1.000		
<i>ftse_gr</i>	0.528***	0.361***	0.271***	1.000	
<i>selfdisclosed_sdg</i>	-0.037***	-0.041**	0.040*	0.019	1.000

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Sustainable business practices

Refinitiv ESG

To assess sustainable business practices, we turn towards traditional ESG ratings and choose Refinitiv's ESG database (Refinitiv, 2021). This database is well-established in the academic literature for the measurement of CSR (Dyck, Lins, Roth, & Wagner, 2019; Ferrell, Liang, & Renneboog, 2016; Flammer, 2021; Gasser, Rammerstorfer, & Weinmayer, 2017). At annual frequency, Refinitiv acquires information from annual reports, corporate sustainability reports, and other company disclosures for large, publicly traded companies in more than 45 countries. Companies are rated along three dimensions ("pillars"): environment, social, and corporate governance. The composite ESG score includes 186 indicators, ranges from 0 to 100 and is adjusted to different industries. Some of the indicators only apply to certain industries. The final score captures the ESG performance relative to all other companies in a given year. Therefore, it is suitable for identifying companies driving the transformation towards greater sustainable business practices in their industries. For the construction of indices, we use the pillar scores. To measure their performance, we also report the composite ESG score.

Sustainalytics Controversies and Global Standards Screening

We complement the assessment of sustainable business practices with media-based data on companies' ESG controversies and their compliance with the UN Global Compact Principles (Sustainalytics, 2021a, 2021c). According to Sustainalytics, controversies are identified by an intelligent, learning algorithm which searches approximately 60,000 different sources. Each potential controversy ("incident") is evaluated according to five assessment factors: severity of the incident, accountability, exceptionality, notoriety, and exposure. Multiple incidents may be attributed to events that pertain to the same ESG issues, which are classified into 40 event indicators. For example, a series of employee strikes is assigned to the "Labor Relations" event indicator (Sustainalytics, 2021a). Events are then rated from 1 (low) to 5 (severe) with respect of their impact on the environment, society, and the individual companies. The final controversy ratings are based on the highest event rating for each company and reviewed by sector analysts, who also assess the preparedness of the company, the company response, the trend of similar incidents, and the overall business impact. All controversy ratings are reviewed at least every 12 months. We denote the variable as CR.

In addition, we use Sustainalytics' Global Standards Screening for the selection of index constituents. Companies are assessed as regards their compliance with the UN Global Compact

Principles and can receive one of the following statuses: non-compliant, watchlist, or compliant (Sustainalytics, 2021c). This assessment is based on their data on ESG incidents, which is reviewed by a dedicated committee of senior analysts. Notably, Morningstar, Inc., one of the leading providers of independent investment research, integrates Sustainalytics' ESG assessments in its rating methodology for approximately 20,000 mutual funds and ETFs (Morningstar, 2021c). Based on Sustainalytics' assessment we created an indicator variable GC, which is 1 if companies are compliant with the UN Global Compact Principles, and 0 otherwise.

Table 4: Variable definitions

Source	Variable	Name: Description	Calculation
ISS SDG SA	OS+	<i>Positive SDG Contribution</i> : indicator variable that equals 1 if at least one objective score is positive and no other objective score is negative, otherwise 0.	Own calculation
	OS•	<i>Neutral SDG Contribution</i> : indicator variable that equals 1 if all objective scores are zero, otherwise 0.	Own calculation
	OS–	<i>Negative SDG Contribution</i> : indicator variable that equals 1 if at least one objective score is negative, otherwise 0.	Own calculation
	ΣOS	<i>Total SDG Contribution</i> : sum of the 15 objective scores that each ranges between +10 (significant contribution) and -10 (significant obstruction).	Own calculation
Sustainalytics Controversies Research	CR	<i>Controversy Score</i> : variable that rates controversies on a scale from 1 to 5, higher numbers indicate more severe controversies. The score is 0 in case of no controversies.	Data provider
	GC	<i>Global Compact Compliance</i> : indicator variable that equals 1 if a company is compliant with the UN Global Compact based on controversies, otherwise 0.	Own calculation
Refinitiv ESG	ESG	<i>ESG Score</i> : variable that reflects companies' industry-adjusted ESG performance based on self-reported information from 0 to 100, higher numbers indicate a better performance.	Data provider
	E / S / G	<i>E Score / S Score / G Score</i> : variables that reflect companies' industry-adjusted environmental, social, or governance performance based on self-reported information from 0 to 100, higher numbers indicate a better performance	Data provider
ISS SDG SA, Refinitiv ESG, Sustainalytics	SDI	<i>SDI Score</i> : variable that captures alignment with the SDI definition based on product/services and sustainable business practices (controversies and ESG), for detailed calculation see table 9.	Own calculation

b. Sample and descriptive statistics

This section provides descriptive statistics about our dataset for the selection of index constituents. The sample of companies is given by the cross-section of the selected data providers: ISS SDG SA, Refinitiv ESG, and Sustainalytics. We use the list of ISINs of companies in the ISS SDG

SA database as a starting point. We also require that information about the companies' GICS industry classification and their headquarters' country of domicile and stock exchange country of domicile be available from the Refinitiv Eikon database. Table A5 shows the ISS SDG SA dataset coverage from 2016 to 2019 across GICS sectors (panel A) and regions of exchange listing (panel B). As can be seen from the table, the number of companies in the dataset increases from 1,389 to 4,499 over this period.

As shown in table 5 (panel A), this base sample is reduced due to missing Refinitiv ESG or Sustainability coverage. The final sample is an unbalanced panel of 10,305 firm-year observations from 5,362 unique companies. Panel B shows that companies listed in America make up the largest part of the sample. Table 6 presents summary statistics. It shows that our metrics for the classification of products and services and the sustainability of business practices vary significantly across GICS industry groups. The lowest and highest average total SDG contribution (ΣOS) have companies in the "Energy" and "Pharmaceuticals, Biotechnology & Life Sciences" industry groups with ratings of -11.12 and 8.02, respectively. Likewise, almost all companies in certain industries (e.g., Food & Staples Retailing) have at least one negative SDGA Objective ($OS- = 1$). The ESG ratings for the sustainability of business practices vary less across industries than SDGA Objectives. This is consistent with the conceptual differences between SDG ratings and ESG ratings described in table 2. Table 7 shows the frequency of controversies across industries. It shows that about 13% of companies have at least significant controversies ($CR > 3$).

Table 5: Final sample

Panel A: Sample construction for index creation					
	2016	2017	2018	2019	Total
Base Sample: ISS SDG SA and Refinitiv Eikon	1,389	2,323	3,708	4,499	11,919
./ No Refinitiv ESG coverage	104	232	299	423	-1,058
./ No Sustainability coverage	78	109	156	213	-556
Final Sample	1,207	1,982	3,253	3,863	10,305
Panel B: Coverage by year and region of stock exchange					
	2016	2017	2018	2019	Total
Africa	12	28	40	41	121
America	445	803	1,490	2,073	4,811
Asia	308	560	741	738	2,347
Europe	410	499	758	791	2,458
Oceania	32	92	224	220	568
Total	1,207	1,982	3,253	3,863	10,305

Table 6: Summary statistics of final sample

GICS Industry Group	N	(%)	Share				ΣOS	Mean of			
			OS- = 1	OS+ = 1	OS• = 1	GC = 1		E	S	G	CR
Automobiles & Components	218	(2%)	63%	17%	21%	89%	-3.00	52.70	53.01	52.16	1.54
Banks	778	(7%)	32%	14%	54%	95%	-0.05	34.11	51.54	55.01	1.52
Capital Goods	1,012	(9%)	56%	28%	16%	92%	-1.24	45.40	50.37	51.62	1.32
Commercial & Professional Services	286	(2%)	32%	44%	24%	96%	0.84	40.78	53.00	58.74	1.22
Consumer Durables & Apparel	253	(2%)	44%	31%	25%	100%	0.01	47.24	54.93	51.05	1.30
Consumer Services	335	(3%)	77%	14%	9%	98%	-5.21	36.26	49.32	51.24	1.49
Diversified Financials	472	(4%)	33%	13%	54%	98%	-0.08	29.56	48.86	51.54	1.27
Energy	403	(3%)	94%	1%	5%	84%	-11.12	45.78	50.47	56.02	1.42
Food & Staples Retailing	174	(1%)	99%	1%	0%	95%	-2.36	46.69	52.66	53.51	1.65
Food, Beverage & Tobacco	508	(4%)	90%	7%	2%	92%	-7.20	50.60	53.92	52.55	1.58
Health Care Equipment & Services	515	(4%)	5%	93%	3%	98%	8.02	27.48	49.03	52.46	1.13
Household & Personal Products	115	(1%)	48%	46%	6%	98%	0.50	50.14	59.94	61.64	1.63
Insurance	481	(4%)	44%	51%	6%	99%	0.79	35.38	50.78	59.26	1.39
Materials	784	(7%)	46%	26%	28%	91%	-0.90	53.06	54.43	59.50	1.65
Media & Entertainment	318	(3%)	8%	49%	42%	97%	0.48	25.39	44.57	45.38	1.07
Pharmaceuticals, Biotechnology & Life Sciences	681	(6%)	4%	95%	1%	95%	8.23	24.17	50.34	44.73	0.92
Real Estate	692	(6%)	3%	70%	27%	99%	2.22	42.26	52.24	50.52	0.47
Retailing	356	(3%)	76%	13%	12%	99%	-1.29	33.40	47.05	52.25	1.21
Semiconductors & Semiconductor Equipment	175	(1%)	11%	48%	41%	100%	2.06	49.77	59.00	57.44	0.69
Software & Services	380	(3%)	3%	72%	25%	98%	2.49	28.28	52.73	47.23	0.77
Technology Hardware & Equipment	294	(2%)	18%	60%	22%	93%	1.44	44.19	54.06	54.44	0.96
Telecommunication Services	249	(2%)	4%	92%	3%	92%	1.93	48.83	55.11	56.92	1.63
Transportation	350	(3%)	76%	15%	9%	99%	-3.22	45.01	49.27	52.24	1.35
Utilities	476	(4%)	55%	38%	7%	95%	1.32	53.62	52.30	57.81	1.51
Total	10,305	(100%)	41%	40%	20%	95%	0.04	40.37	51.52	53.17	1.27

Table 7: Final sample – Sustainalytics Controversies across industries

GICS Industry Group	Share					
	CR = 0	CR = 1	CR = 2	CR = 3	CR = 4	CR = 5
Automobiles & Components	30%	17%	33%	12%	6%	2%
Banks	28%	20%	31%	17%	4%	1%
Capital Goods	36%	17%	32%	12%	3%	1%
Commercial & Professional Services	36%	23%	30%	8%	1%	2%
Consumer Durables & Apparel	29%	17%	48%	6%	0%	0%
Consumer Services	22%	22%	41%	13%	1%	0%
Diversified Financials	36%	15%	36%	11%	2%	0%
Energy	30%	24%	27%	14%	3%	2%
Food & Staples Retailing	24%	17%	36%	20%	3%	1%
Food, Beverage & Tobacco	23%	24%	29%	20%	4%	0%
Health Care Equipment & Services	39%	25%	22%	12%	2%	0%
Household & Personal Products	19%	19%	41%	21%	0%	0%
Insurance	20%	27%	46%	6%	0%	0%
Materials	23%	19%	37%	15%	4%	2%
Media & Entertainment	39%	26%	27%	6%	2%	0%
Pharmaceuticals, Biotechnology & Life Sciences	55%	18%	13%	9%	3%	2%
Real Estate	68%	20%	9%	2%	1%	0%
Retailing	31%	26%	36%	6%	1%	0%
Semiconductors & Semiconductor Equipment	60%	18%	18%	3%	2%	0%
Software & Services	57%	14%	23%	5%	1%	0%
Technology Hardware & Equipment	47%	19%	26%	4%	3%	0%
Telecommunication Services	24%	19%	33%	20%	3%	1%
Transportation	31%	18%	38%	11%	0%	1%
Utilities	22%	23%	41%	11%	2%	1%
Total	36%	20%	30%	11%	2%	1%

c. Selection of index constituents

This subsection outlines the data sources and thresholds we use for selecting index constituents in the hypothetical SDI-aligned index.

Step 1 of the SDI decision tree assesses the following condition:

“Does the activity (i.e., products/ services or projects) financed contribute significantly to the SDGs?”

Possible outcomes of the first step are:

1. The contribution is negative ($OS^- = 1$) → Exclusion from the index.
2. The contribution is neutral ($OS^0 = 1$) → Inclusion in step 2.
3. The contribution is positive ($OS^+ = 1$) → Inclusion in step 2.

We exclude any companies that have at least one objective score that is negative ($OS^- = 1$). Consequently, we can reasonably assume that none of the index constituents obstruct any of the SDGs through their products or services. We keep all companies with either all objective scores being neutral ($OS^0 = 1$) or with at least one objective score being positive ($OS^+ = 1$). These companies are then assessed in the second step.

Depending on the first outcome, step 2 of the SDI decision tree assesses whether business practices are consistent with sustainable development objectives or whether the company contribute to a positive transformation in its industry through its sustainable business practices, respectively. Possible outcomes of the second step are:

1. Inclusion in the index
2. Exclusion from the index

Following these conditions, we define different thresholds for inclusion in the index based on the outcome of the first step. If the first outcome was neutral, we require that these companies be top performers in terms of the sustainability of their business practices. These firms must be highly rated across the environmental, social, and governance dimensions with each of the Refinitiv ESG pillar scores above 75. This corresponds to a grade of A-. We set this value lower to 33.3 for companies with a positive contribution through products and services. This corresponds to a grade score of C. Moreover, for all companies we require that they have experienced

no significant controversies (CR < 3) and that they are compliant with the UN Global Compact (GC = 1). Exemplarily, based on data for 2019, this selection approach results in 559 index constituents. The selection procedure is also depicted in table 8. Index constituents are selected at the beginning of each year t based on the ratings from the previous year t-1.

Table 8: Selection of index constituents based on 2019 data

Panel A reports how the index constituents are selected based on the SDI Decision Tree. The selected number of companies refers to the selection based on 2019 data. Panel B shows the selection matrix, which includes the assessment of products and services on the left-hand side, the lowest ESG pillar score on the top. The inclusion/ exclusion based on controversies is presented within the matrix cells related to the other two selection criteria, whereas the first number shows how many companies pass the controversy screening criteria (CR<3 and GC=1) and the second number how many companies are not compliant with the UN Global Compact, have severe controversies or both. The matrix refers to the index selection based on 2019 data; bold numbers are the number of companies that are ultimately selected. For variable definitions see table 4.

Panel A: Selection along the SDI decision tree

Step	Description	Criteria	✓/X	Outcome	No. companies
1	<i>Does the activity (i.e., products/ services or projects) financed contribute significantly to the SDGs?</i>	OS+ = 1	✓	Include in step 2 → POSITIVE	1,579
		OS• = 1	✓	Include in step 2 → NEUTRAL	917
		OS– = 1	✓	Exclude from index → NEGATIVE	(1,367)
2	POSITIVE (Step 1) <i>Are business practices consistent with sustainable development objectives?</i>	E & S & G >= 33.3	✓	Include in index	551
		CR < 3 GC = 1	X	Exclude from index	(1,028)
	NEUTRAL (Step 1) <i>Does the company contribute to a positive transformation in its industry through its sustainable business practices?</i>	E & S & G >= 75	✓	Include in index	8
		CR < 3 GC = 1	X	Exclude from index	(909)

Panel B: Selection matrix across SDG/ESG/Controversy Ratings

Controversy (CR<3 and GC=1/ otherwise)		Lowest ESG Pillar Score			
		< 33.3	33.3 – 75	≥ 75	
Products & Services	OS+ = 1	928 (894 / 34)	576 (496 / 80)	75 (55 / 20)	1,579 (1,445 / 134)
	OS• = 1	624 (603 / 21)	275 (225 / 50)	18 (8 / 10)	917 (836 / 81)
	OS– = 1	721 (666 / 55)	585 (434 / 151)	61 (24 / 37)	1,367 (1,124 / 243)
		2,273 (2,163 / 110)	1,436 (1,155 / 281)	154 (87 / 67)	3,863 (3,405 / 458)

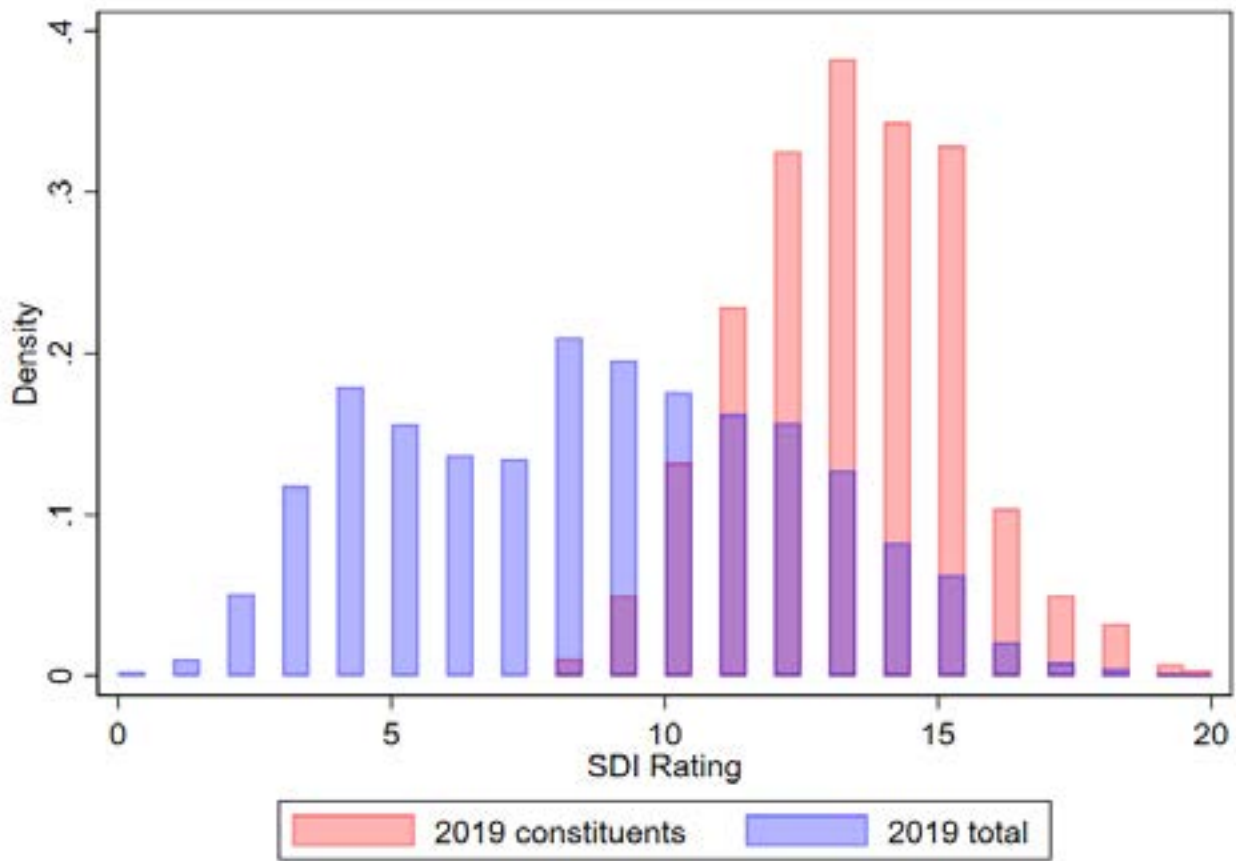
d. SDI Rating

Using the data described above, we construct an overall SDI rating for each company which can be used to adjust the company weights in the index to maximize the impact for sustainable development of the index. It can also be used to compare the SDI contribution of our indices against a benchmark. Specifically, the SDI rating ranges from 0 to 20 and is composed as illustrated in table 9. The rating methodology gives equal weight to companies' SDG contribution through products and services and through sustainable business practices. We developed this methodology to exemplarily construct a single rating, which reasonably incorporates the different measurements described above. Figure 3 shows the distribution of the SDI rating of the total sample and the selected index constituents based on 2019 data.

Table 9: SDI rating methodology

SDG Contribution	Condition	Max SDI Rating	Criteria	Points
Products and services	The company does not obstruct any of the SDGs.	4	OS- = 0	4
	The company makes a significant contribution to one SDG.	3	At least one objective score is greater than 5	3
	The company contributes to one or multiple SDGs.	3	More than two objective scores are positive	3
			Two objective scores are positive	2
			One objective score is positive	1
	Sustainable business practices	6	For each pillar $E / S / G \geq 75$	2
			For each pillar $50 < E / S / G < 75$	1
		3	CR = 0	3
			CR = 1	2
			CR = 2	1
	The company is compliant with the UN Global Compact.	1	GC = 1	1

Figure 3: SDI rating histogram



e. Conceivable weighting approaches

In the last subsection, we outlined how we select the companies for the construction of an SDI-aligned index. In this subsection we give an overview of how we weight the stocks of the selected companies. In the subsection after that, we describe the weighting approaches in detail and report on the respective performance of the hypothetical indices.

As we have seen in the previous discussions in this paper, most providers of impact indices equal- or value-weight the stocks of the preselected companies. In an equal-weight weighting, the same weight is given to each stock in a portfolio. The weight w of asset i at time t is therefore given as

$$w_{it} = \frac{1}{N_t}$$

where N is the number of assets in the portfolio. Thus, in an equal-weighted portfolio, the small-

est companies are given the same weight as the largest companies. Small-cap stocks are generally considered to have higher potential return but also to be riskier than large-caps.

Another widely adopted weighting is to weight stocks based on their market capitalization, hence giving higher weights to larger stocks. Compared to an equal-weighting approach, this causes minimal turnover because equal-weighting requires frequent rebalancing. If the assets in the portfolio are value-weighted, the weight w of asset i at time t is given as

$$w_{it} = \frac{MV_{it-1}}{\sum_{i=1}^N MV_{it-1}}$$

where MV_{it-1} is the market-value of firm i at time $t-1$.

In addition to equal- and value-weighting, the weights of the assets can also be determined so that the portfolio meets specific return, risk, and/ or SDG requirements. In the following, we introduce two approaches to this. The first can be described as passive portfolio management or index tracking. Here, the preselected assets are weighted so that the portfolio replicates the risk-return profile of a given benchmark. The logic behind this approach could be that the pre-selected assets already meet investors' SDG requirements. In this case, when determining the asset weights, investors may only be interested in generating a risk-return profile that they would achieve even without concentrating on assets with a high SDG contribution. We use the MSCI All Countries World Index (MSCI ACWI) as a benchmark, which is MSCI's flagship global equity index, representing the performance of the full opportunity set of large- and mid-cap stocks across 23 developed and 27 emerging markets. The second approach can be referred to as active portfolio management. Here, the assets are weighted so that the resulting portfolio meets the investors' specific return, risk, and SDG requirements. Both optimization approaches are described in more detail in the next subsection. Also in the next subsection, we report the return, risk, and SDG performance of the benchmark and the hypothetical indices based on our four weightings. However, note that the analysis of the different weightings is purely demonstrative in nature. The point is not to determine something like the best possible portfolio allocation, but to show how investors' varying demands can be met.

f. Risk-return-SDG-ESG profiles of selected hypothetical SDG-aligned indexes

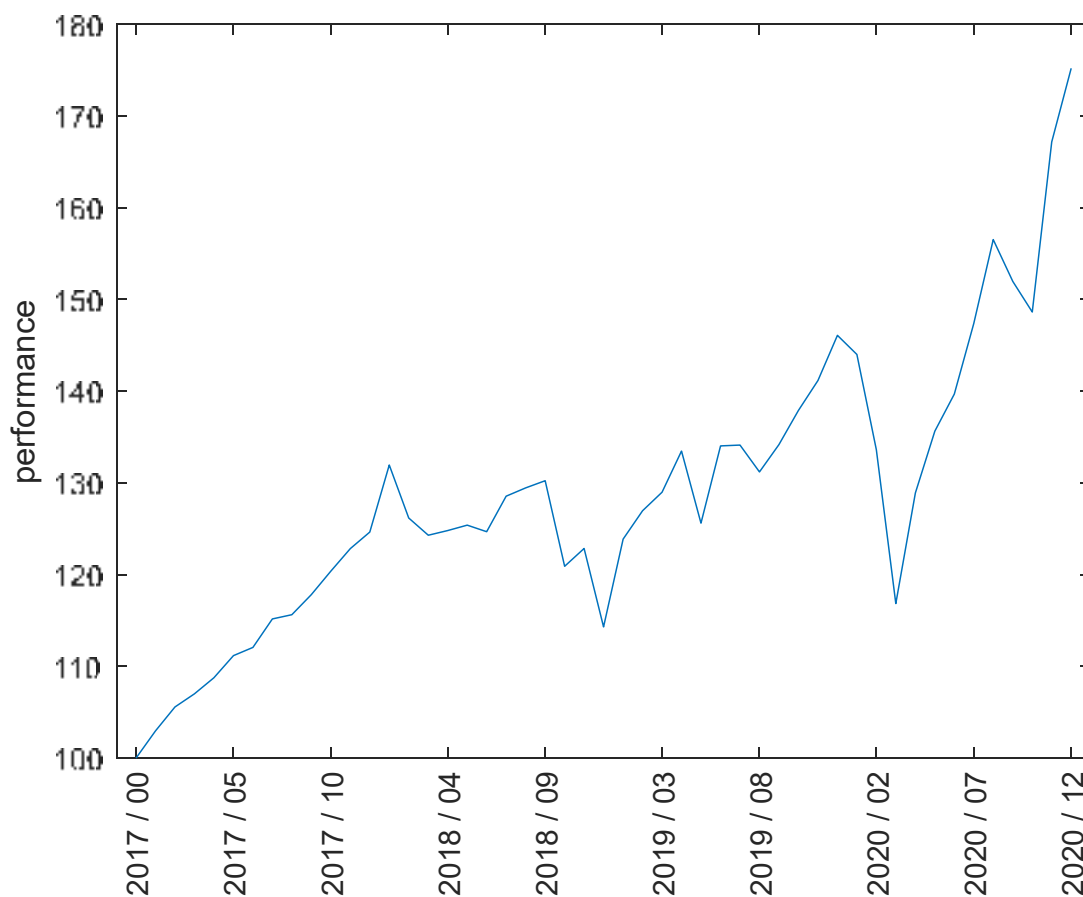
In this subsection we report the return, risk, and SDG performance of the benchmark (MSCI ACWI) and our four hypothetical indices based on different weightings, (1) an equal-weighted

portfolio (EW), (2) a value-weighted portfolio (VW), (3) a tracking portfolio (Tracking), and (4) a multi-objective portfolio (Risk/ Return/ SDG). Due to data availability, the information on performance in terms of return and risk relates to the period 2017-2020. All other information on the performance or composition of the portfolio does not relate to a period but to a point in time, more precisely to the most recent observation. In the following, we first present the performance of the benchmark and then discuss the performance of the four hypothetical indices.

Benchmark portfolio - MSCI ACWI

Figure 4 shows the performance of the benchmark over the period 2017-2020.

Figure 4: Performance of the MSCI ACWI



Starting with a value of 100 at the beginning of 2017 (2017/00), the MSCI ACWI has a value of approx. 175 at the end of 2020 (2012/12). Panel A of table 10 reports the respective descriptive statistics. According to these figures, the MSCI ACWI has an average annualized return of 14.96%, annualized volatility of 15.68% and risk-return ratio of 0.95, which means that 1% more risk is compensated for with almost 1% more return. Panel B of table 10 provides additional information on the SDG/ ESG profile and panel C provides information on the composition of the portfolio. We discuss many of the numbers in more detail later when we compare them with the numbers on the four hypothetical indices. For the moment we would like to point out the data availability in particular. This shows that there is ISS SDG SA coverage for only 52.53% of the companies in the MSCI ACWI, Sustainalytics coverage for 87.96% of the companies, and Refinitiv ESG coverage for 97.87% of the companies. This results in a coverage of 51.08% of the companies for our SDI measure.

Table 10: Performance of the MSCI ACWI

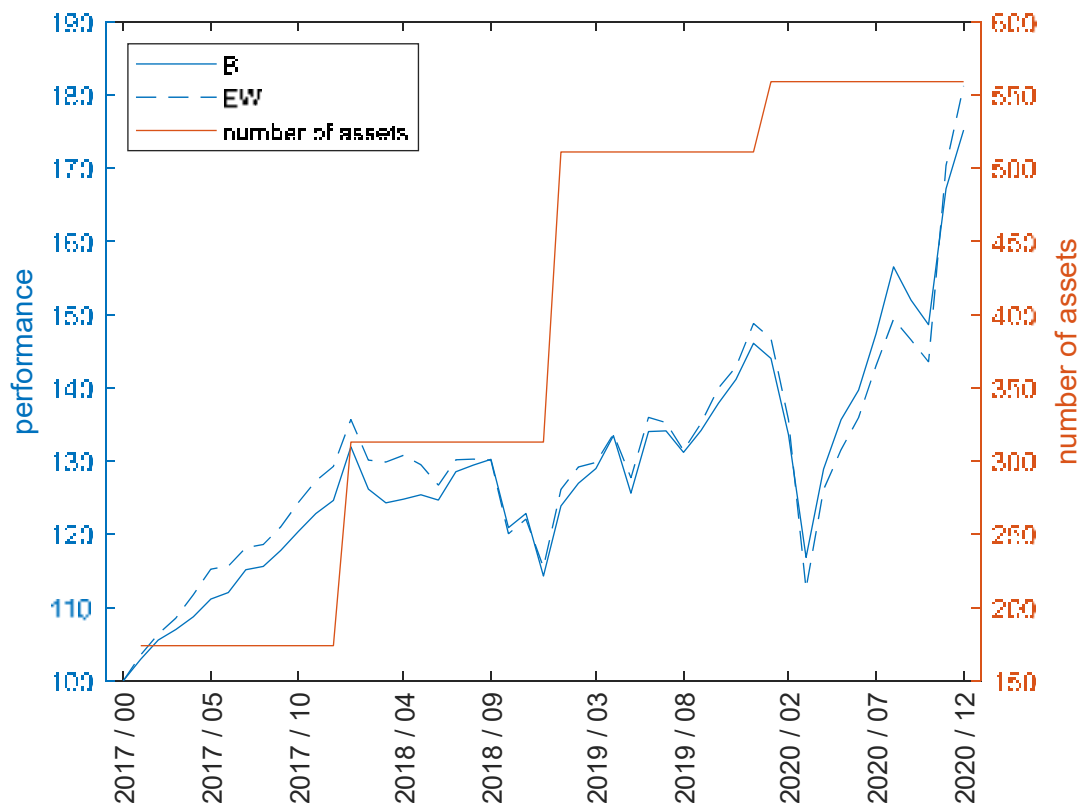
The table reports descriptive statistics on the MSCI ACWI. Panel A reports information on performance that relates to the period 2017-2020. Panel B reports information on the SDG/ESG profile and Panel C on the composition that relates to the most recent observation. In Panel A, "Return (p.a.)" is the annualized average return of the portfolio, "Std. dev. (p.a.)" is the annualized standard deviation of the portfolio return, and "Return / Std. dev." is the annualized return-risk ratio of the portfolio. This ratio equals the Sharpe ratio if the risk-free rate is assumed to be zero in the respective time period. Panel B provides information on the ESG, SDG, and SDI contribution based on data from ISS SDG SA, Sustainalytics, and Refinitiv ESG. For a detailed description of these measures, we refer to Section 4. a. Panel C provides information on the number of assets in the portfolio ("Number of assets"), the largest and the smallest three asset weight percentages, the largest and the smallest three firms in the portfolio (in USD billions), and the three countries (headquarters as reported by Thomson Reuters) and industries with the largest weight percentages. The column "data availability" shows the proportion of assets for which information is available in panel B.

Benchmark index – MSCI		
Panel A – Risk/ Return Profile		
Return (p.a.)		14.96%
Std. dev. (p.a.)		15.68%
Return / Std. dev.		0.95
Panel B – SDG/ ESG Profile		Data availability
Total SDG Contribution (ΣOS)	0.56	52.53%
Negative SDG Contribution (OS– = 1)	67.61%	52.53%
Controversy Score (CR)	2.29	87.96%
Global Compact Compliance (GC = 1)	92.79%	87.96%
ESG Score	65.96	97.87%
E Score	62.56	97.87%
S Score	69.61	97.87%
G Score	63.01	97.87%
SDI Score	9.23	51.08%
Panel C – Composition		
Number of assets		2,828
Largest weights	Apple Inc	2.95%
	Microsoft Corp	2.63%
	Amazon.com Inc	1.99%
Smallest weights	Harmonic Drive Systems Inc	0.00%
	Wuhan Guide Infrared Co Ltd	0.00%
	Adani Green Energy Ltd	0.00%
Largest market value (in USD billions)	Apple Inc	2,085.57
	Microsoft Corp	1,860.87
	Amazon.com Inc	1,407.42
Smallest market value	Harmonic Drive Systems Inc	0.43
	Wuhan Guide Infrared Co Ltd	0.40
	Adani Green Energy Ltd	0.13
Largest country weights	United States of America	52.47%
	China	10.16%
	Japan	4.63%
Largest industry weights	Software & Services	9.45%
	Banks	8.39%
	Media & Entertainment	6.91%

Hypothetical index I - Equal-weighted portfolio (EW)

We turn our focus to the equal- and value-weighted portfolio. This is not only interesting because most index providers take this approach. It also delivers initial insights into how the risk-return profile of assets with a high SDG contribution compares to assets without such a preselection. Figure 5 shows the performance of the equal-weighted portfolio (and the number of assets in the portfolio) compared to the benchmark.

Figure 5: Performance of the hypothetical index I - Equal-weighted portfolio (EW)



It seems worth mentioning that the risk-return profile of our preselected assets is very close to that of the benchmark. This is all the more interesting as the number of assets differs significantly. At the end of 2020 there are around 2,800 assets in the benchmark while around 600 assets are in the portfolio. The sharp increase in the number of assets in the portfolio from around 175 in 2017 to around 600 in 2020 is due in particular to an increase in the coverage of the ISS SDG SA database. Table 11 provides additional information on the performance and composition of the portfolio. While the risk-return profile of the EW portfolio and the benchmark are very similar, the EW portfolio shows overall stronger values with regard to the ESG, SDG, and SDI contribution.

Table 11: Performance of the hypothetical index I - Equal-weighted portfolio (EW)

For a description of the variables used in the table, we refer to the caption of table 10.

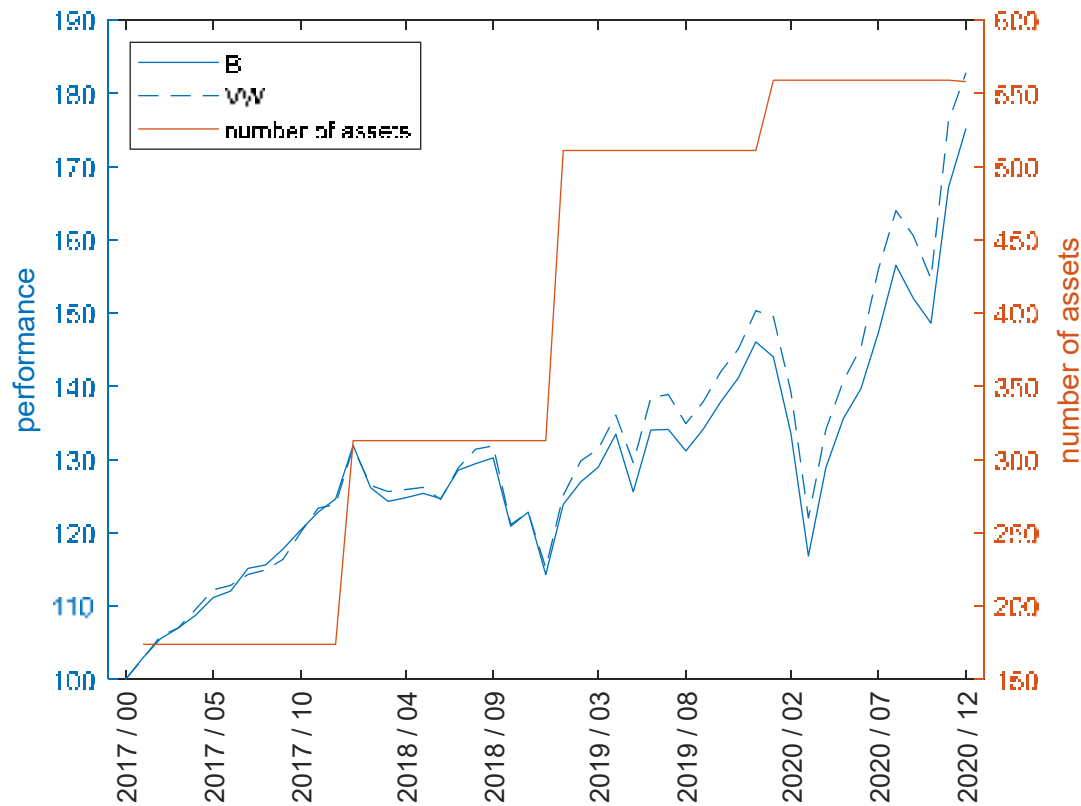
Hypothetical index I - Equal-weighted portfolio (EW)			
Panel A – Risk/ Return Profile			
Return (p.a.)			15.92%
Std. dev. (p.a.)			18.22%
Return / Std. dev.			0.87
Panel B – SDG/ ESG Profile			
Total SDG Contribution (Σ OS)			4.02
Negative SDG Contribution (OS– = 1)			0.00%
Controversy Score (CR)			1.07
Global Compact Compliance (GC = 1)			100.00%
ESG Score			66.12
E Score			64.46
S Score			67.88
G Score			64.87
SDI Score			13.15
Panel C – Composition			
Number of assets			559
Top 3 market value (in USD billions)	Taiwan Semiconductor Manufacturing Co. Ltd.		459.77
	NVIDIA Corp.		300.61
	Comcast Corp.		239.53
Bottom 3 market value	Enel Generación Chile S.A.		0.18
	China Everbright Water Ltd.		0.13
	Infigen Energy Ltd.		0.01
Top 3 countries	United States of America		25.22%
	Japan		7.69%
	United Kingdom		7.51%
Top 3 industries	Real Estate		16.10%
	Materials		9.12%
	Capital Goods		8.41%

We do not provide information on the largest and smallest asset weights because in the EW portfolio, all weights are the same. The largest firms in our preselected asset universe are TSMC, NVIDIA, and Comcast, contrasting with Apple, Microsoft, and Amazon in the MSCI ACWI. Table A6 provides additional insights into the calculation of the sum of the ISS objectives for the largest and smallest firms in the index. We also find that the proportion of US companies in the EW portfolio is significantly lower than in the benchmark, and that the industry distribution differs significantly, too. Nevertheless, note that the country and industry proportions in the EW portfolio result from an equal weighting, while the composition of the MSCI ACWI is based on a value weighting. With this in mind, we now look at the value weighting of the assets we have preselected.

Hypothetical index II - Value-weighted portfolio (VW)

Figure 6 shows the performance of the value-weighted portfolio (and the number of assets in the portfolio) compared to the benchmark. In the value-weighted portfolio, we limit the maximum weight of an asset to 3% to ensure that the impact of individual assets in terms of risk (idiosyncratic risk) does not become too high. This aligns well with the benchmark where the largest weight is 2.95% (Apple). We can see from Table 12 that several companies would otherwise have exceeded the 3% limit.

Figure 6: Performance of the hypothetical index II - Value-weighted portfolio (VW)



We find that the risk and return metrics are very similar to the equal-weighted portfolio and to the benchmark. Additionally, we find that the ESG/ SDG metrics are very similar to the EW portfolio and thus superior to the benchmark. Compared to the benchmark, the proportion of US companies is lower (40.3% versus 52.5%), indicating a more even distribution across countries. In the VW portfolio and the benchmark, “Software & Services” forms the largest industry. Overall, the proportions of the three largest industries are slightly larger than in the benchmark portfolio.

Table 12: Performance of the hypothetical index II - Value-weighted portfolio (VW)

For a description of the variables used in the table, we refer to the caption of table 10.

Hypothetical index II - Value-weighted portfolio (VW)		
Panel A – Risk/ Return Profile		
Return (p.a.)		16.17%
Std. dev. (p.a.)		15.87%
Return / Std. dev.		1.02
Panel B – SDG/ ESG Profile		
Total SDG Contribution (Σ OS)		3.56
Negative SDG Contribution (OS– = 1)		0.00%
Controversy Score (CR)		1.53
Global Compact Compliance (GC = 1)		100.00%
ESG Score		71.98
E Score		69.15
S Score		75.81
G Score		69.52
SDI Score		13.18
Panel C – Composition		
Number of assets		558
Largest weights	Taiwan Semiconductor Manufacturing Co. Ltd.	3.00%
	NVIDIA Corp.	3.00%
	Comcast Corp.	3.00%
Smallest weights	Enel Generación Chile S.A.	0.00%
	China Everbright Water Ltd.	0.00%
	Infigen Energy Ltd.	0.00%
Largest market value	Taiwan Semiconductor Manufacturing Co. Ltd.	459.77
(in USD billions)	NVIDIA Corp.	300.61
	Comcast Corp.	239.53
Smallest market value	Enel Generación Chile S.A.	0.18
	China Everbright Water Ltd.	0.13
	Infigen Energy Ltd.	0.01
Largest country weights	United States of America	40.27%
	Japan	9.14%
	Germany	6.30%
Largest industry weights	Software & Services	13.60%
	Semiconductors & Semiconductor Equipment	11.43%
	Pharmaceuticals, Biotechnology & Life Sciences	9.33%

Hypothetical index III - Tracking portfolio (Tracking)

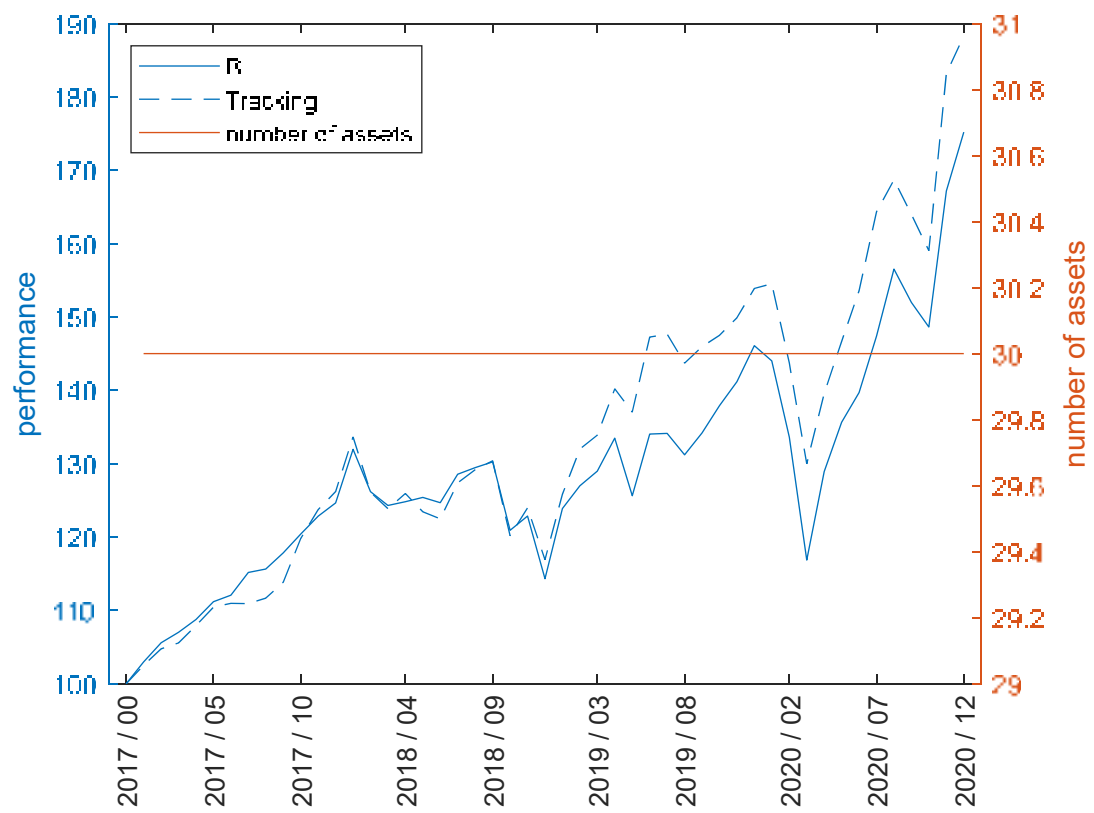
The above considerations have shown that the EW portfolio and the VW portfolio have a very similar risk-return profile to the benchmark. However, this does not always have to be the case. In this context, we would also like to point out that four years is not a sufficiently long backtesting period (albeit being due to data availability) to allow a valid statement about this. In addition,

it could be of interest to build the portfolio from a significantly smaller number of assets (as is common practice with index providers). In the following, we therefore show how to create a portfolio from just a few assets (30 assets with the largest free-float market capitalization in the preselected asset universe), which is then optimized to match the risk-return profile of the benchmark as closely as possible. This is also known as passive portfolio management or index tracking. There are a variety of approaches to index tracking in the literature, many of which require the estimation of a reliable covariance matrix. This is particularly problematic if the number of assets is high and/ or there are many missing values. We therefore rely on the approach described in Poddig, Varmaz, and Fieberg (2015) which is quite flexible in dealing with the above issues but is based on an unorthodox definition of the tracking error (sum of squared residuals). The objective of this approach is to minimize the sum of squared residuals between the target and the tracking portfolio

$$\begin{aligned} \min & \frac{1}{T} \sum_{t=1}^T (r_t^B - r_t^P)^2 \\ & \text{s.t.} \\ & \sum_{i=1}^N w_i = 1 \end{aligned}$$

where r_t^B is the return of the benchmark (target) portfolio and r_t^P is the return of the tracking portfolio. It can therefore be interpreted as a least squares estimation under constraints. In each month t we use the most recent 60 return observations of the benchmark portfolio and the most recent 60 return observations of the 30 largest assets to solve the above optimization problem. This provides us with the weights of the 30 assets which we can then use to determine the portfolio return in month $t + 1$. Figure 7 shows the performance of the tracking portfolio compared to the benchmark.

Figure 7: Performance of the hypothetical index III - Tracking portfolio (Tracking)



As expected, we find that the risk and return metrics are very similar to the benchmark and that the ESG and SDG measures outperform the respective benchmark measures. However, the tracking portfolio outperforms the benchmark somewhat in the second half of the sample period. Additionally, the smaller number of assets in the tracking portfolio results in more extreme asset weights and country and industry distributions compared to the approaches discussed above, see table 13. However, the index tracking approach used here is flexible enough to deal with a significantly larger number of assets.

Table 13: Performance of the hypothetical index III - Tracking portfolio (Tracking)

For a description of the variables used in the table, we refer to the caption of table 10.

Hypothetical index III - Tracking portfolio (Tracking)			
Panel A – Risk/ Return Profile			
Return (p.a.)			17.03%
Std. dev. (p.a.)			15.12%
Return / Std. dev.			1.13
Panel B – SDG/ ESG Profile			
Total SDG Contribution (Σ OS)			2.08
Negative SDG Contribution (OS $^-$ = 1)			0.00%
Controversy Score (CR)			1.73
Global Compact Compliance (GC = 1)			100.00%
ESG Score			73.00
E Score			68.70
S Score			77.20
G Score			71.05
SDI Score			12.54
Panel C – Composition			
Number of assets			30
Largest weights	Comcast Corp.		6.56%
	Allianz SE		6.45%
	Chubb Ltd.		6.20%
Smallest weights	Advanced Micro Devices Inc.		0.00%
	NVIDIA Corp.		0.00%
	Sony Corp.		0.00%
Largest market value	Taiwan Semiconductor Manufacturing Co. Ltd.		459.77
(in USD billions)	NVIDIA Corp.		300.61
	Comcast Corp.		239.53
Smallest market value	Sherwin-Williams Co.		61.41
	Zurich Insurance Group AG		60.40
	Air Products and Chemicals Inc.		56.83
Largest country weights	United States of America		38.99%
	Switzerland		9.76%
	Germany		9.47%
Largest industry weights	Software & Services		20.64%
	Insurance		19.60%
	Materials		16.39%

Hypothetical index IV - Multi-objective portfolio (Risk/ Return/ SDG)

In contrast to index tracking where the preselected assets are weighted so that the portfolio replicates the risk-return profile of a given benchmark, one could also imagine weighting the assets in such a way that the resulting portfolio meets investors' individual return, risk, and SDG preferences. In this context, Gasser et al. (2017) suggest incorporating sustainability preferences in the traditional mean-variance (Markowitz) approach. Following this approach, investors

maximize returns, maximize sustainability measures, and minimize risk.

$$\begin{aligned} & \max \alpha \mu_p + \gamma \theta_p - \beta \sigma_p^2 \\ & \text{s.t.} \\ & \sum_{i=1}^N w_i = 1 \end{aligned}$$

where μ_p is the expected portfolio return $\mu_p = \sum_{i=1}^N \mu_i w_i$

θ_p is the expected sustainability measure $\theta_p = \sum_{i=1}^N \theta_i w_i$

σ_p^2 is the expected portfolio risk (variance) $\sigma_p^2 = \sum_{i=1}^N \sum_{j=1}^N \sigma_i \sigma_j w_i w_j \rho_{ij}$

ρ_{ij} is the correlation between asset i and asset j , and α , γ , and β represent investors' return, sustainability, and risk preferences. Instead of specifying specific preferences, the approach can be reformulated in such a way that some of the objectives must meet predetermined target values:

$$\begin{aligned} & \min \sigma_p^2 \\ & \text{s.t.} \\ & \sum_{i=1}^N w_i = 1 \\ & \sum_{i=1}^N \mu_i w_i = \mu_p^* \\ & \sum_{i=1}^N \theta_i w_i = \theta_p^* \end{aligned}$$

This approach minimizes portfolio risk while the portfolio return and sustainability measure correspond to specific target values μ_p^* and θ_p^* . However, the problem with this approach is that investors have to form expectations about the future return and risk of the assets under consideration. However, Varmaz, Fieberg, and Poddig (2021) show that under the assumption of a valid asset pricing model like the capital asset pricing model (CAPM), the above optimization approach can be reformulated as follows:

$$\min \frac{1}{2} w^T w$$

s.t.

$$w^T \mathbf{1} = 1$$

$$w^T \beta = \beta_p^*$$

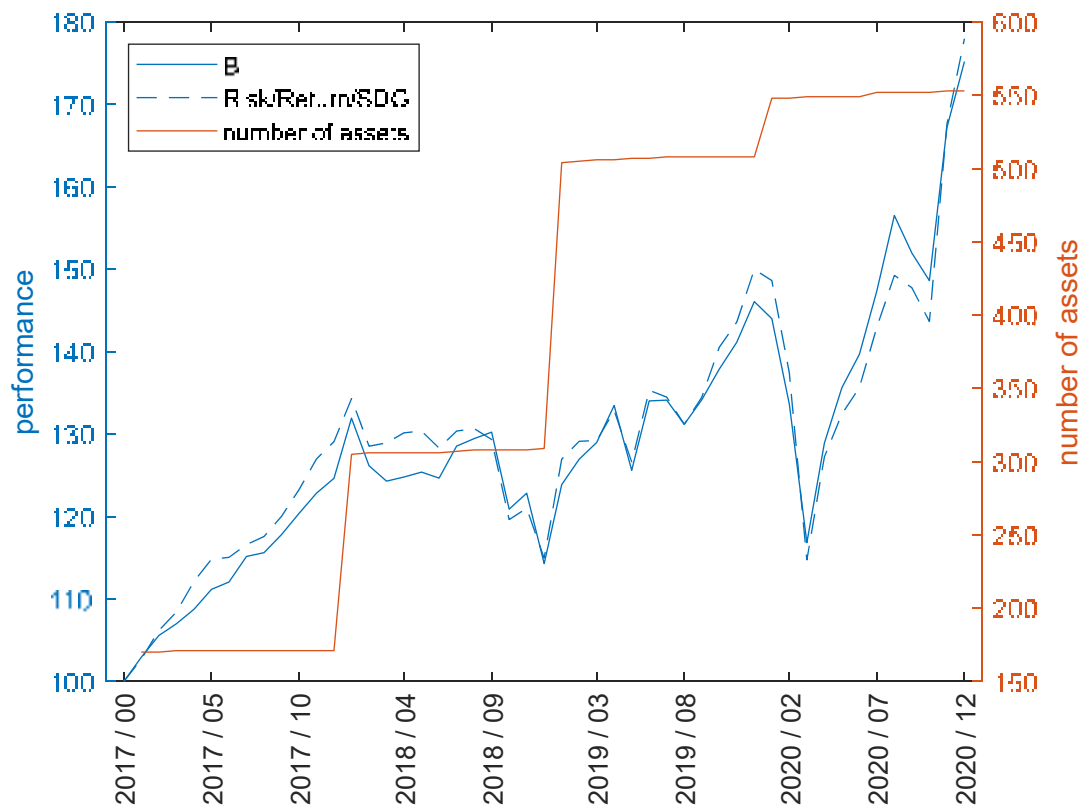
$$w^T \theta = \theta_p^*$$

where β_p^* is the target value for the sensitivity of the portfolio to the market portfolio. In contrast to the optimization approaches above, there is no need to determine a covariance matrix of the considered assets or their expected returns. Instead, “only” the sensitivities of the assets to the market portfolio are required. This considerably reduces the estimation effort and the potential for estimation errors. In simple terms, the aim of this approach is to find a portfolio with the lowest possible asset concentration, while the sensitivity of the portfolio to the market and the sustainability metric meet the specified target values.

In the following application we assume that the sustainability measure of interest is our developed SDI Score, the risk-free interest rate is zero, and the market portfolio corresponds to the MSCI ACWI. In addition, we assume that the target sensitivity to the market portfolio is equal to one and the desired SDI Score is equal to 15.²⁸ The sensitivities of the assets are estimated every month based on the most recent 60 return observations. On this basis, the asset weights can be determined in each month t using the above optimization framework. This allows us to calculate the portfolio return in month $t + 1$. Figure 8 shows the performance of the tracking portfolio compared to the benchmark.

²⁸ Under these conditions, the portfolio can also be viewed as a tracking portfolio for which the additional restriction applies that a certain sustainability value should be achieved.

Figure 8: Performance of the hypothetical index IV - Multi-objective portfolio (Risk/ Return/ SDG)



Again, we find that the risk and return metrics are very similar to the benchmark. Additionally, Table 14 shows that the ESG, SDG, and SDI measures are superior compared to the three hypothetical indices discussed before. This is achieved through the restriction that the SDI Score should target a value of 15. Due to the objective function, this portfolio also has the smallest asset weights so that there are no large concentrations and idiosyncratic risks are reduced. This is also reflected in country distribution, so that US companies have a significantly lower share than in the portfolios examined so far.

Table 14: Performance of the hypothetical index IV - Multi-objective portfolio (Risk/ Return/ SDG)

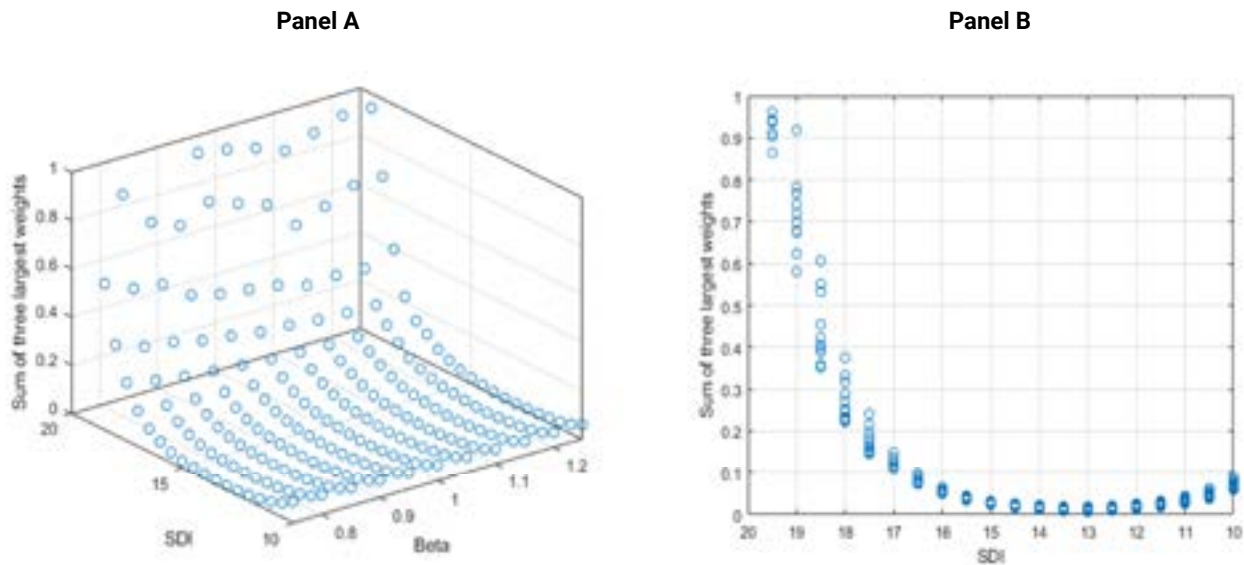
For a description of the variables used in the table, we refer to the caption of table 10.

Hypothetical index IV - Multi-objective portfolio (Risk/Return/SDG)		
Panel A – Risk/ Return Profile		
Return (p.a.)		15.40%
Std. dev. (p.a.)		17.54%
Return / Std. dev.		0.88
Panel B – SDG/ ESG Profile		
Total SDG Contribution (Σ OS)		5.93
Negative SDG Contribution (OS $^-$ = 1)		0%
Controversy Score (CR)		0.97
Global Compact Compliance (GC = 1)		100.00%
ESG Score		71.76
E Score		70.37
S Score		73.98
G Score		69.57
SDI Score		15.00
Panel C – Composition		
Number of assets		553
Largest weights	Gecina S.A.	0.87%
	Sonova Holding AG	0.80%
	Humana Inc.	0.71%
Smallest weights	Kennedy-Wilson Holdings Inc.	0.01%
	Regis Healthcare Ltd.	0.01%
	QTS Realty Trust Inc.	0.01%
Largest market value (in USD billions)	Taiwan Semiconductor Manufacturing Co. Ltd.	459.77
	NVIDIA Corp.	300.61
	Comcast Corp.	239.53
Smallest market value	Enel Generación Chile S.A.	0.18
	China Everbright Water Ltd.	0.13
	Infigen Energy Ltd.	0.01
Largest country weights	United States of America	22.52%
	Japan	10.47%
	France	7.88%
Largest industry weights	Real Estate	15.53%
	Health Care Equipment & Services	12.41%
	Pharmaceuticals, Biotechnology & Life Sciences	9.65%

In order to examine how the return and risk of the portfolio as well as the concentration of the assets in the portfolio react to a change in the input parameters of the optimization, we vary the required SDI Score between 10 and 20 and the required beta between 0.75 and 1.25. Figure 9 (panel A) shows the concentration of assets in the portfolio as a function of SDI and beta. The

concentration of the assets in the portfolio is measured as the sum of the largest 3 weights in the portfolio. We find that the concentration is not heavily dependent on beta. In contrast, there is a strong relation between concentration and SDI. To analyze this relationship in more detail, it is shown in Figure 9 (panel B) in a 2D plot. It can be seen that the concentration increases sharply from an SDI Score of 16. The explanation for this is that we have very few assets with an SDI Score above 15 in our sample. These assets are therefore weighted above average.

Figure 9: Relation between SDI, beta and concentration of the assets in the portfolio



By analyzing the relationship between concentration and SDI, one can derive the expectation that higher concentration will also affect the return and risk of the portfolio. Figure 10 (panel A) therefore show the relationship between SDI, beta and return. As expected (from economic theory), we find that the higher the beta, the higher the return (panel B). We also find that the return (regardless of beta) starts to decrease from an SDI Score of 15.5 (panel C). This is due to the high concentration of assets. A higher concentration results in less diversified portfolios and therefore in higher idiosyncratic risks.

Figure 10: Relation between SDI, beta and return

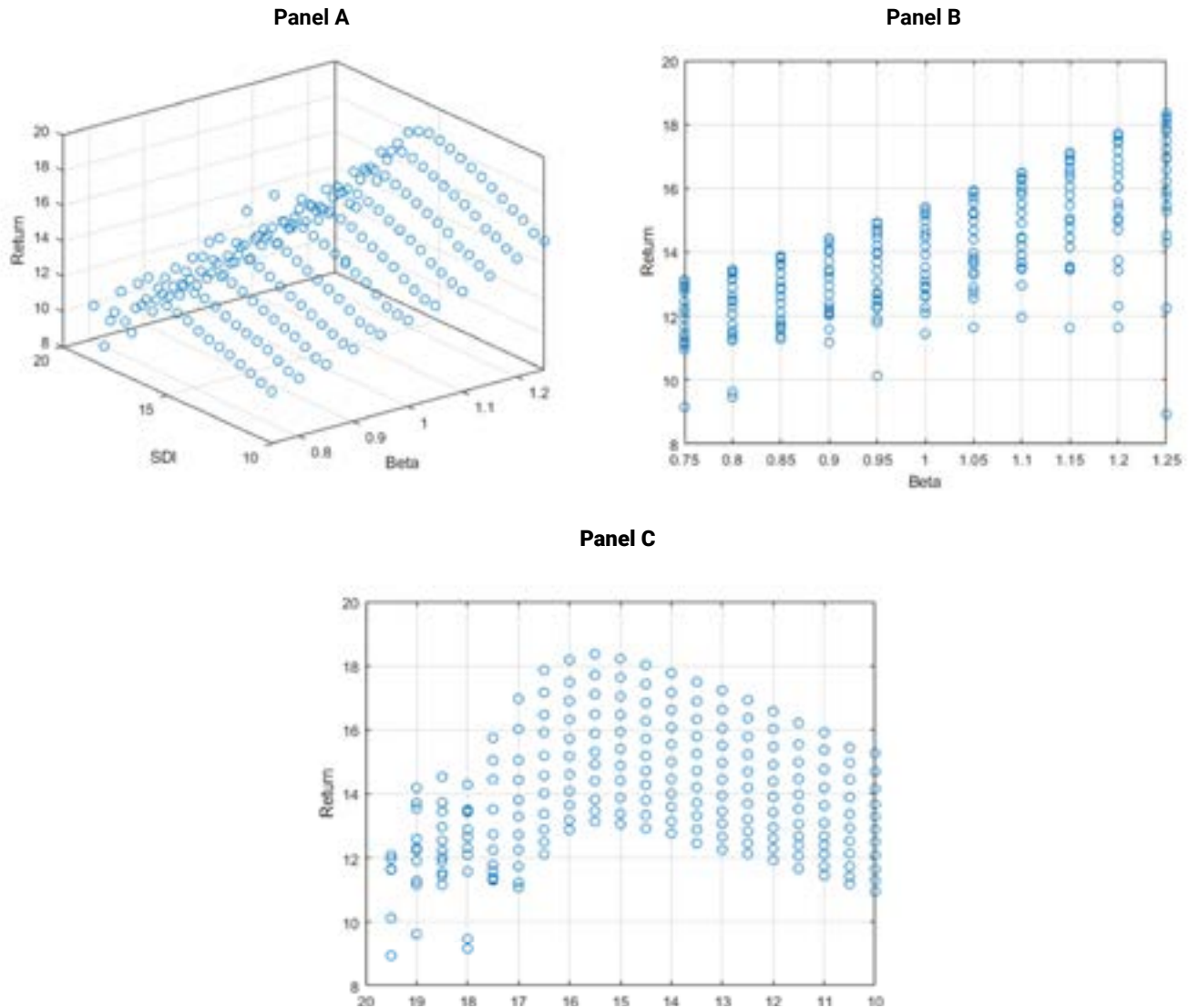
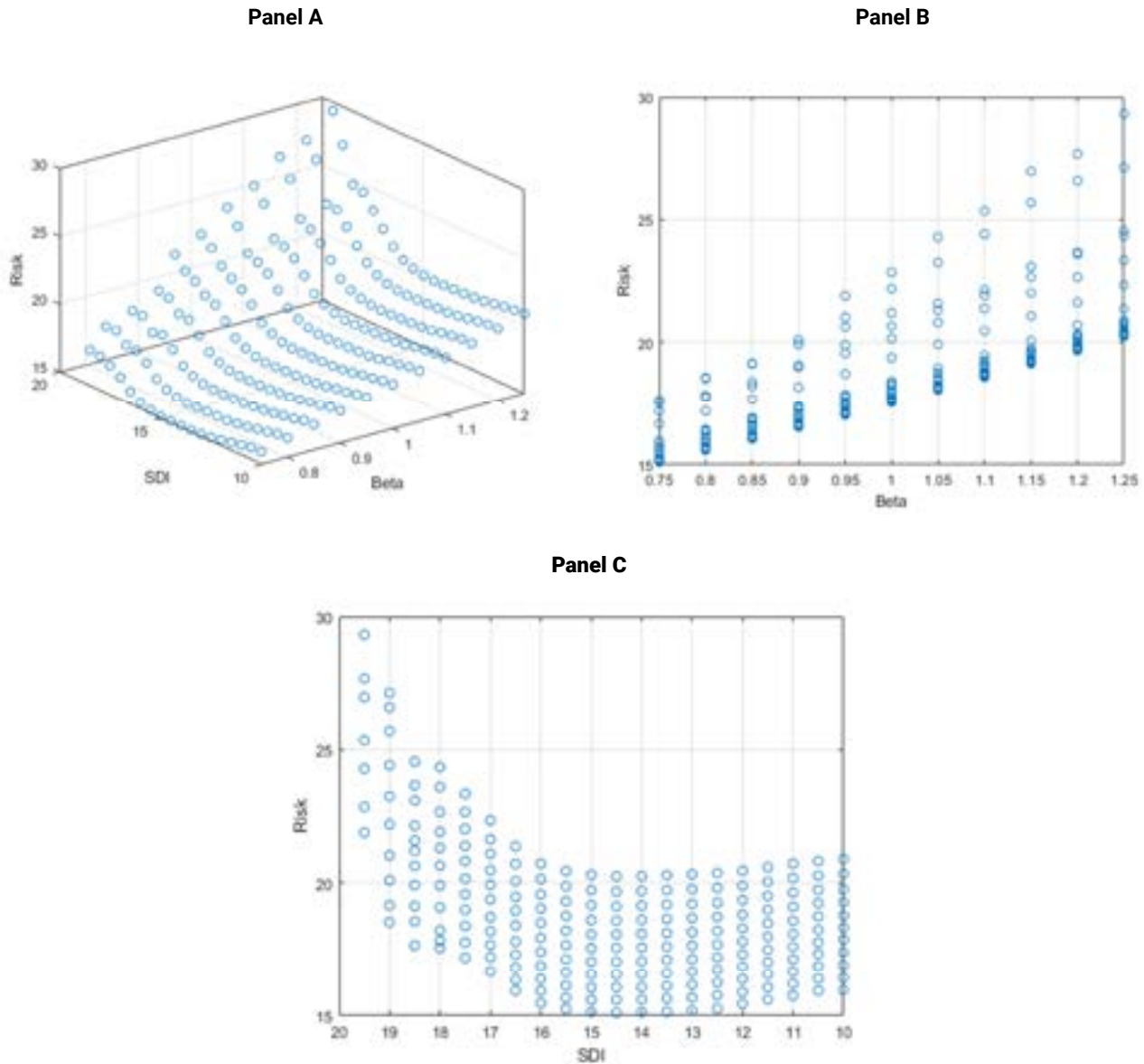


Figure 11 (panel A) shows the relationship between SDI, beta and risk. As expected (from economic theory), we find that the higher the beta, the higher the risk (panel B). We also find that the risk (regardless of beta) starts to increase from an SDI Score of 15.5 (panel C). This is again due to the high concentration of assets resulting in higher idiosyncratic risks. The recommendation derived from this analysis is that when setting targets for SDI, the relationship between the SDI Score and the concentration of assets in the portfolio should first be examined.

Figure 11: Relation between SDI, beta and risk



In summary, we can conclude that all four hypothetical indices have a very similar risk-return profile as the MSCI ACWI and have higher ESG, SDG, and SDI Scores. Even so, the fact of a similar risk-return profile should not be overstated. This can change with longer observation periods, a different preselection of the assets or an increase in coverage by the database providers. We have shown how, under these circumstances, a risk-return profile similar to that of the benchmark can be achieved (tracking portfolio). In addition, we have outlined how ESG, SDG, and SDI measures can be considered when determining optimal asset weights (multi-objective portfolio).

5. Conclusion

In this paper we examine the implementation options of the SDI definition for equity investors. The main task is to provide guidance on how to create an equity index that aligns with the SDI definition. Because an assessment of the firms' alignment with the SDI definition on an ongoing, case-by-case basis is not feasible, it is necessary to rely on commercial solutions recently developed by major data providers. In this context, we analyze the suitability of numerous data providers for ESG and SDG measures. We find that it would be desirable if data providers were to include further information related to the SDI definition. In addition, an expansion of the coverage, especially with a view to developing countries, is desirable. However, it should not go unmentioned that many promising approaches (such as those by the World Benchmarking Alliance) are still being developed. Time will tell whether these approaches can fill the aforementioned gaps. Weighing up numerous factors, while other approaches are possible, we conclude that a combination of the data providers ISS ESG, Sustainalytics, and Refinitiv ESG is currently well suited to represent the SDI definition. This allows us to select companies that best meet the SDI definition. Based on this, we construct hypothetical stock indices and compare their risk, return, and SDI alignment performance with the MSCI ACWI benchmark. When constructing the hypothetical indices, we attempt to represent a wide range of investor types. For all approaches we find similar risk-return profiles as for the benchmark but higher ESG and SDG values and thus, SDI alignment. Given our construction of the SDI Score, we find that the optimal average value of constituents in the multi-objective portfolio is around 15. Beyond this threshold, the concentration of asset weights increases significantly, resulting in higher risk. Table 15 once again summarizes our main results.

Table 15: Summary - Performance of the hypothetical indices and the benchmark

	EW	VW	Tracking	Risk/ Return/SDG	Benchmark
Return (p.a.)	15.92%	16.17%	17.03%	15.40%	14.96%
Std. dev. (p.a.)	18.22%	15.87%	15.12%	17.54%	15.68%
Return/Std. dev.	0.87	1.02	1.13	0.88	0.95
Number of assets	559	558	30	553	2,828
Total SDG Contribution (Σ OS)	4.02	3.56	2.08	5.93	0.56
Negative SDG Contribution (OS ⁻ = 1)	0.00%	0.00%	0.00%	0.00%	67.619%
Controversy Score (CR)	1.07	1.53	1.73	0.97	2.29
Global Compact Compliance (GC = 1)	100.00%	100.00%	100.00%	100.00%	92.79%
ESG Score	66.12	71.98	73.00	71.76	65.96
SDI Score	13.15	13.18	12.54	15.00	9.23

Appendix

Table A1: Data - Combined assessment of SDG alignment based on products/ services and general business practices (selection)

Data base	Description (from source document)
ISS ESG <i>Impact Rating</i> (~ 6,500 firms)	ISS provides data on how companies' operations, controversies and products/ services contribute or obstruct every single SDG. An aggregated score on an SDG level across the three pillars as well as an aggregated SDG score across all individual SDGs is provided. The assessment of a company's products/ services is leveraged from ISS SDG Solutions Assessment Objective Scores. The assessment of a company's operational impact is based on standard and industry-specific indicators from the ESG Rating that are mapped based on their thematic relevance to the individual SDGs. For every SDG, ISS ESG provides a controversy score. The SDG assessment of companies is based on evaluating allegations that companies fail to abide by global norms as set out in the relevant international initiatives and guidelines. Source: https://www.issgovernance.com/esg/impact-un-sdg/sdg-impact-rating/
MSCI <i>SDG Alignment</i> (~ 8,600 firms)	The underlying framework is based on the understanding that companies may contribute to the goals in a variety of ways, both positive and negative, through their operations and the products/ services they provide. The framework is powered by data inputs from various MSCI research products (Sustainable Impact Metrics, ESG Controversies, ESG Ratings and Business Involvement Screening Research). The data offers assessments (Strongly Aligned, Aligned, Neutral, Misaligned, and Strongly Misaligned) and scores for the two dimensions, product/services and operations, and an aggregated evaluation for each company and for each of the 17 SDGs. Source: https://www.msci.com/our-solutions/esg-investing/impact-solutions
Vigeo Eiris <i>SDG Assessment</i> (~ 4,500 firms)	Vigeo Eiris assesses a company's contribution to achieving the SDGs through their behaviour and product offering. Thereby, Vigeo Eiris provide information on companies' strengths and weaknesses against the achievement of the SDGs along a framework of eight themes. The overall contribution is rated from highly positive and positive over marginal to adverse and highly adverse. Companies are benchmarked against their geographic peers. Source: https://vigeo-eiris.com/solutions-investors/sustainable-development-goals/

Table A2: Data – SDG contribution through products/ services (selection)

Data base	Description (from source document)
ENTIS/ SDI AOP <i>SDI Scores</i> (~ 7,900 firms)	Based on 151 product categories that are labeled SDI, the data provides information on companies' revenue share that contributes to the SDGs. In scope are SDGs 1 to 15, whereas the criteria for operations/ conduct-related SDGs (5, 8, 10) are still under development. Each assessment comes with an indication of the confidence level of the product classification and its revenue share which are retrieved from publicly available information. 1,653 companies were identified as SDI; 1,037 as majority plays (>50% SDI-aligned revenue) and 616 as decisive plays (10-50% SDI-aligned revenue). 19% of SDI companies have one (or more) warning flag(s) for involvement in controversial activities (e.g., palm oil production). Source: https://www.sdi-aop.org/how-it-works/
FTSE <i>Green Revenues</i> (~ 16,000 firms)	Companies' environmental contribution based on revenues from related products and services with an impact on climate change mitigation and adaptation, water, resource use, pollution, and agricultural efficiency. The taxonomy for green products and services covers ten subsectors, 64 subsectors and 133 micro sectors. The share of green revenue is provided based on companies' overall revenues. Around 3,000 companies with green revenues have been identified. Source: https://www.ftserussell.com/data/sustainability-and-esg-data/green-revenues-data-model
ISS ESG <i>SDG Solutions Assessment</i> (~ 5,000 firms)	The data measures the contribution to 15 SDG-related sustainability objectives based on companies' revenue from related products and services. The objective scores range from -10 to +10. A rating of +10 means that 100% of net sales are generated with products/services classified as having a significant contributing impact on the respective objective. The final company score is composed of the most distinct objective scores (i.e., the highest positive and/ or the lowest negative score). The taxonomy of products and services is subject to an ongoing review process to include more or new products and services. Source data is from publicly available information as well as company feedback to ISS. Source: https://www.issgovernance.com/esg/impact-un-sdg/sustainability-solutions-assessment/
MSCI <i>Sustainable Impact Solutions</i> (~ 10,300 firms)	MSCI ESG Research refers to a detailed taxonomy of activities, products and/ or services with positive impact on society and the environment. The assessment is based on granular revenue data and measures impact in six environmental impact categories and seven social impact categories. MSCI reports the revenue share that contributes to the impact categories, on the aggregated environmental and social level as well as on the company level. Source: https://www.msci.com/our-solutions/esg-investing/impact%20solutions
VIGEO EIRIS <i>Sustainable Goods & Services</i> (~ 4,500 firms)	Vigeo Eiris defines nine sustainable development themes that are aligned with the SDGs. The revenue of companies' products/ services are used to evaluate the contribution to these themes. The data provides information what percentage of a company's products/ services are contributing to sustainable development across the nine themes. Source: https://vigeo-eiris.com/solutions-investors/sustainable-goods-services/

Table A3: Data – ESG ratings (selection)

Data base	Description (from source document)
ARABESQUE <i>ESG Scores/Global Compact Scores</i> (~ 8,000 firms)	As a basis Arabesque defines 22 categories that include 250 indicators from non-financial disclosures and are adjusted by news-based controversies. The ESG Score is calculated as a weighted sum of the 22 category scores using materiality-based weights which are assessed on a sector and industry level each quarter. The individual ESG pillar scores are calculated with mapped categories. For the UN Global Compact Score, the initial 22 category scores are mapped to the four core principles: Human Rights, Labor Rights, Environment, Anti-corruption. The aggregated GC Score weights every principle initially with 25%, but increases as the principle score starts dropping below the neutral center score. Source: https://www.arabesque.com/de/arabesque-s-ray/our-scores/
FTSE ESG <i>ESG Scores</i> (~ 7,200 firms)	FTSE defines 14 categories for the calculation of the pillar and the total ESG Score. Indicators are selected according to their materiality on a sector and country basis out of 300 indicators in total. On average 125 indicators are applied per company. Companies that are more exposed to particular categories are assessed with higher thresholds. The Pillar Scores are calculated as a weighted average of the category scores by its exposure level. The same logic applies for the overall ESG score with the underlying pillar scores. Both, absolute scores and industry adjusted scores by means of the percentile rank scoring model are provided. Source: https://www.ftserussell.com/data/sustainability-and-esg-data/esg-ratings
REFINITIV ESG <i>ESG Scores</i> (~ 9,000 firms)	186 different ESG indicators based on company disclosures are used to calculate ten category scores. Indicators are evaluated by their materiality for every industry whereas the number of included indicators varies between 70 and 170 per industry. The category scores are calculated with a percentile rank scoring methodology with an industry benchmark for the environmental and social category scores and a country of incorporation benchmark for the governance category scores. The three ESG pillar scores and the final ESG score are relative sums of the category weights. The ESGC Score overlays the ESG score with the ESG Controversies Score. Source: https://www.refinitiv.com/en/sustainable-finance/esg-scores
MSCI <i>ESG Scores</i> (~ 14,000 firms)	Based on the understanding that ESG risks and opportunities can vary by industry and company, the ESG Ratings filters out those issues that are most material to a sub-industry/ sector from a list of 35 Key Issues. Corporate Governance Key Issues are always material. For each company and Key Issue, MSCI provides data on exposure and management. The final ESG Rating is the weighted average of individual Key Issue Scores and benchmarked against the ESG Rating of industry peers. These industry-adjusted scores are translated in ratings between best (AAA) and worst (CCC). Source: https://www.msci.com/our-solutions/esg-investing/esg-ratings
SUSTAINALYTICS <i>ESG Risk Scores</i> (~ 12,000 firms)	The model is based on company's ESG risk exposure estimated along corporate governance and a sub-industry-specific set of up to 10 out of 20 pre-defined material ESG issues. The exposure can be increased through severe ESG controversies. Based on the exposure and by relying on outcome-focused and management indicators, Sustainalytics assesses the (un)managed ESG Risk. Management indicators measure the degree to which a company meets relevant best practice standards, whereas outcome-focused indicators measure management performance in quantitative terms or via a company's involvement in controversies. Companies can engage with Sustainalytics and are contacted during the annual update feedback process and when significant ESG controversies occur. Source: https://www.sustainalytics.com/esg-data
VIGEO EIRIS <i>ESG Assessments</i> (~ 4,500 firms)	Vigeo Eiris has set up 38 ESG criteria that are framed within 40 industry specific models to identify the relevant criteria for each industry. On average, 25 criteria are assessed relevant for a given sector, with an industry-specific materiality weight assigned to each criterion. Each company is assessed on a managerial framework for each relevant ESG criteria: Quality of leadership, Extent of implementation, and Results. The assessments are based on qualitative/ quantitative data and self-reported and third-party data. Source: https://vigeo-eiris.com/solutions-investors/esg-assesments/

Table A4: Data – Controversy ratings (selection)

Score	Description (from source document)
MSCI	
<i>Controversy Score</i> (~ 12,500 firms)	A controversy case is defined as an instance or ongoing situation in which company operations and/ or products allegedly have a negative environmental, social, and/ or governance impact. Each controversy case is assessed for the severity of its impact on society or the environment and consequently rated Very Severe, Severe, Moderate, or Minor. Source: https://www.msci.com/documents/1296102/14524248/MSCI+ESG+Research+Controversies+Executive+Summary+Methodology+++July+2020.pdf/b0a2bb88-2360-1728-b70e-2f0a889b6bd4
REFINITIV	
<i>ESG Controversies</i> (~ 9,000 firms)	Measurement of a company's exposure to environmental, social, and governance controversies. The data is based on a calculation of a controversy percentile rank across E, S and G, using all 23 controversy topics. Zero controversies result in a controversy score of 100%. Source: https://www.refinitiv.com/content/dam/marketing/en_us/documents/methodology/refinitiv-esg-scores-methodology.pdf
REPRISK	
<i>RepRisk Index</i> (~ 79,000 firms)	RepRisk applies a proprietary algorithm that dynamically captures and quantifies a company's exposure to reputational risks related to ESG. It facilitates an initial assessment of the ESG and business conduct risks associated with financing, investing, or doing business with a particular company. Ranges from 0 to 100, lower values indicating lower risk. Source: https://www.reprisk.com/solutions#datasets-and-metrics
SUSTAINALYTICS	
<i>Controversies</i> (~ 20,00 firms)	Sustainalytics monitors 700,000 news items from more than 60,000 media and NGO sources on a daily basis in order to identify potential incidents. An incident is a company activity and is primarily assessed based on its negative environmental and/or social impact as well as the reputational risk that this activity poses to the company. Events are series of isolated or related incidents that pertain to the same ESG issues. Events are classified into 40 Event Indicators which speak to these ESG issues. Events are assessed on a scale of 1 to 5 depending on severity (1=low, 2=moderate, 3=significant, 4=high, 5=severe). Source: https://www.sustainalytics.com/investor-solutions/esg-research/controversies-research
<i>Global Standards Screening</i> (~ 20,00 firms)	Incidents are assessed against international standards, e.g., UN Global Compact Principles. On an ongoing basis companies are assigned with one of the following statuses: "Non-Compliant," "Watchlist," or "Compliant." Proposals for changes in assessments are reviewed and approved by a dedicated committee of senior representatives. Source: https://www.sustainalytics.com/investor-solutions/esg-research/esg-screening/global-compact-norms-based-screening#report

Table A5: ISS ESG SDG Solutions Assessment coverage (base sample)**Panel A: Coverage by year and GICS sector**

	2016	2017	2018	2019	Total
Energy	36	80	120	241	477
Materials	89	166	265	366	886
Industrials	208	366	628	693	1,895
Consumer Discretionary	143	258	403	511	1,315
Consumer Staples	125	229	304	287	945
Health Care	144	197	489	642	1,472
Financials	349	442	517	661	1,969
Information Technology	92	177	313	420	1,002
Communication Services	59	155	221	207	642
Utilities	96	100	162	172	530
Real Estate	48	153	286	299	786
Total	1,389	2,323	3,708	4,499	11,919

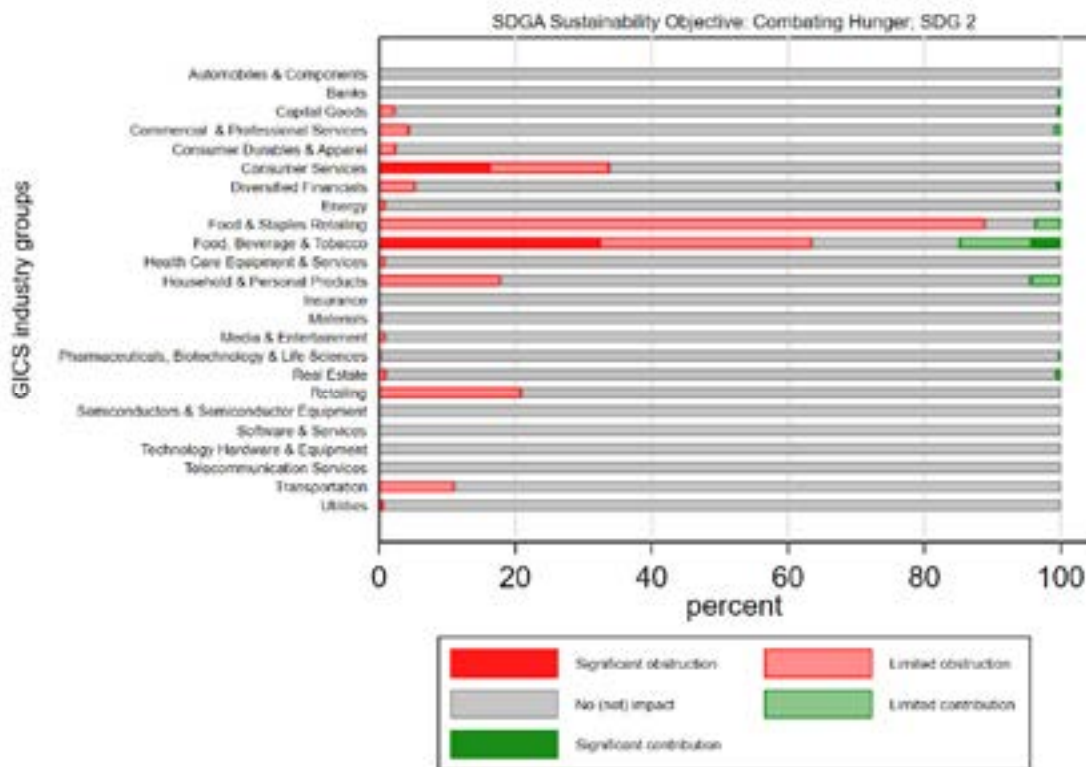
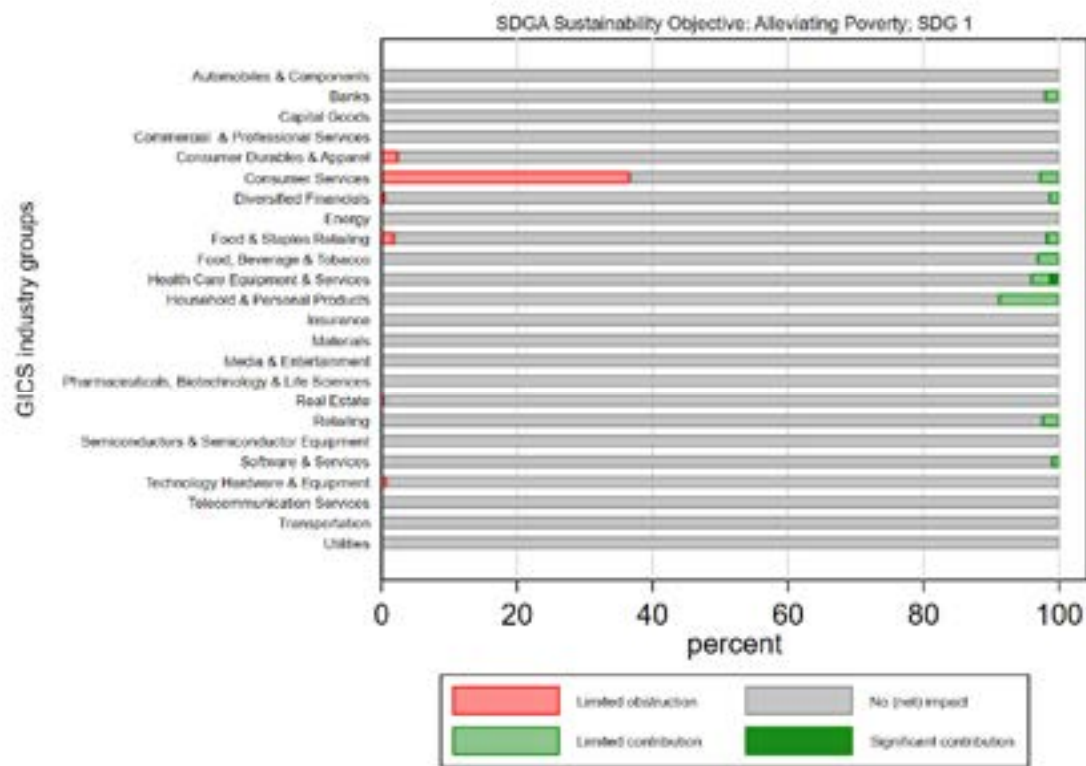
Panel B: Coverage by year and region of stock exchange

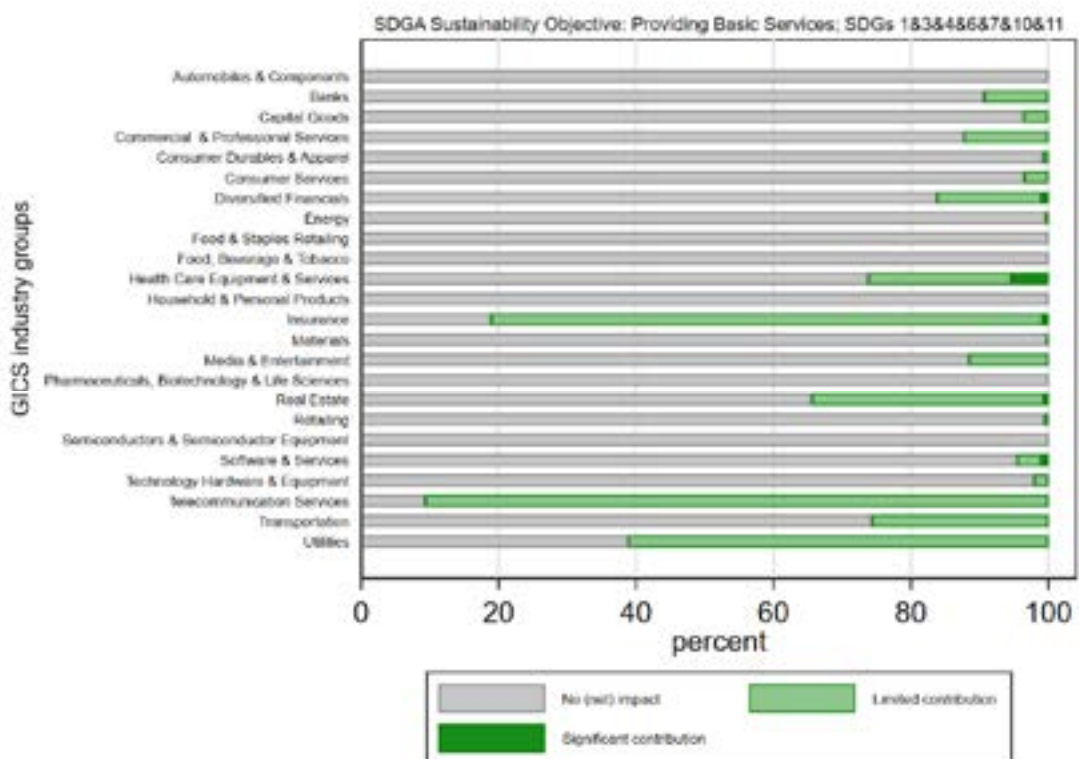
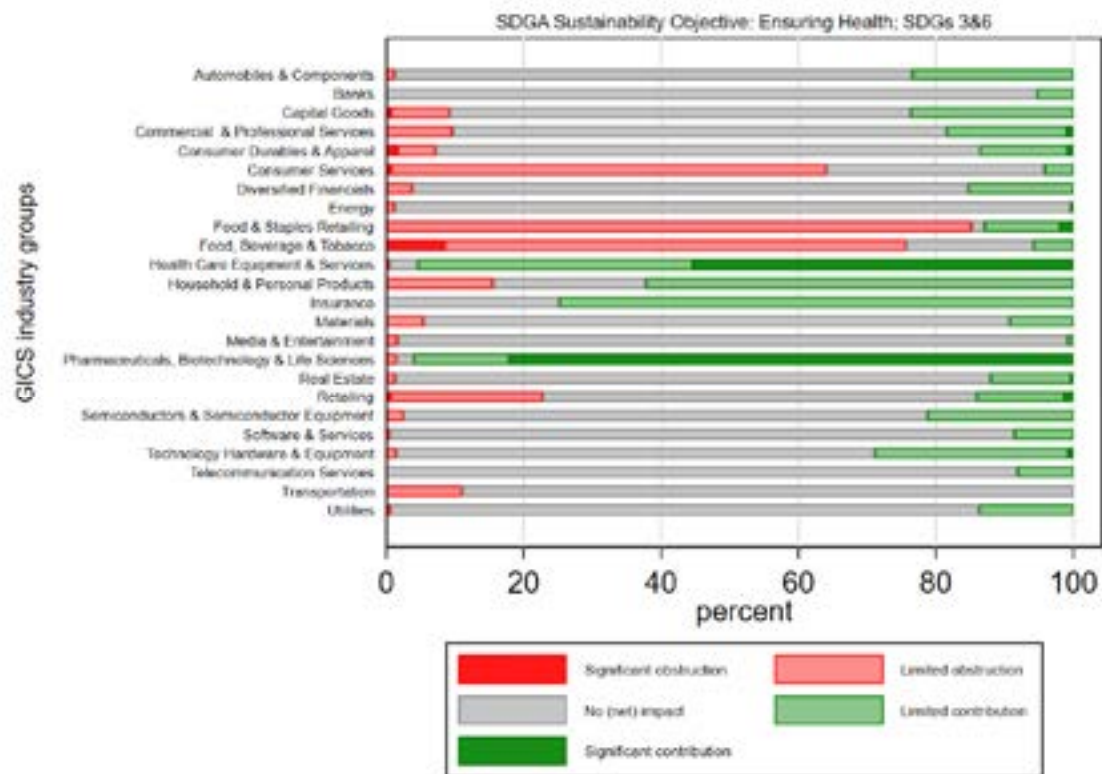
	2016	2017	2018	2019	Total
Africa	14	32	40	44	130
America	477	860	1,652	2,346	5,335
Asia	341	598	774	821	2,534
Europe	524	739	991	1,039	3,293
Oceania	33	94	251	249	627
Total	1,389	2,323	3,708	4,499	11,919

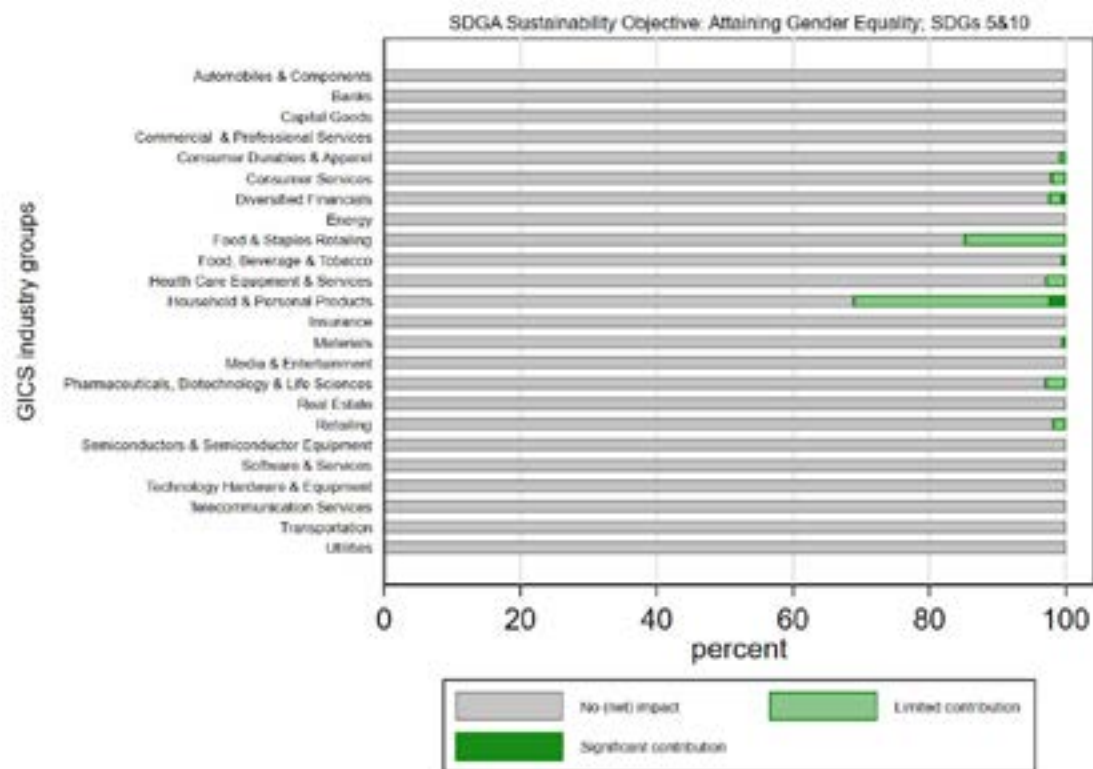
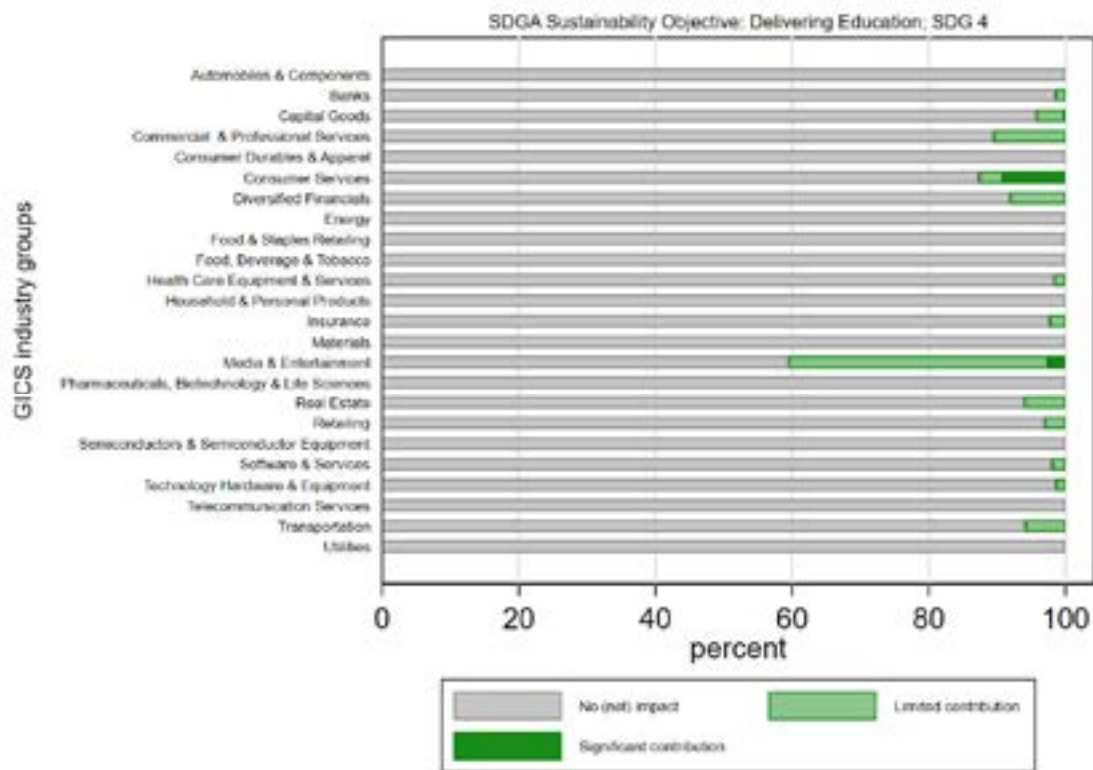
Table A6: ISS objective scores of the largest and smallest three index constituents (2019)

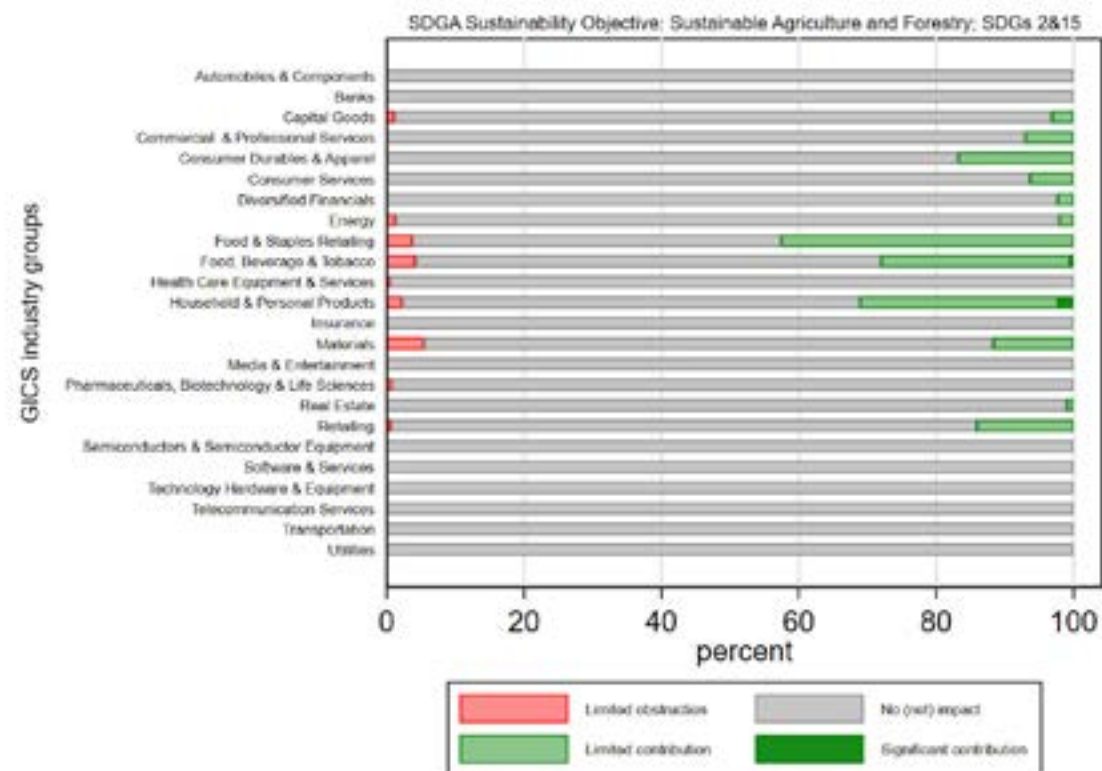
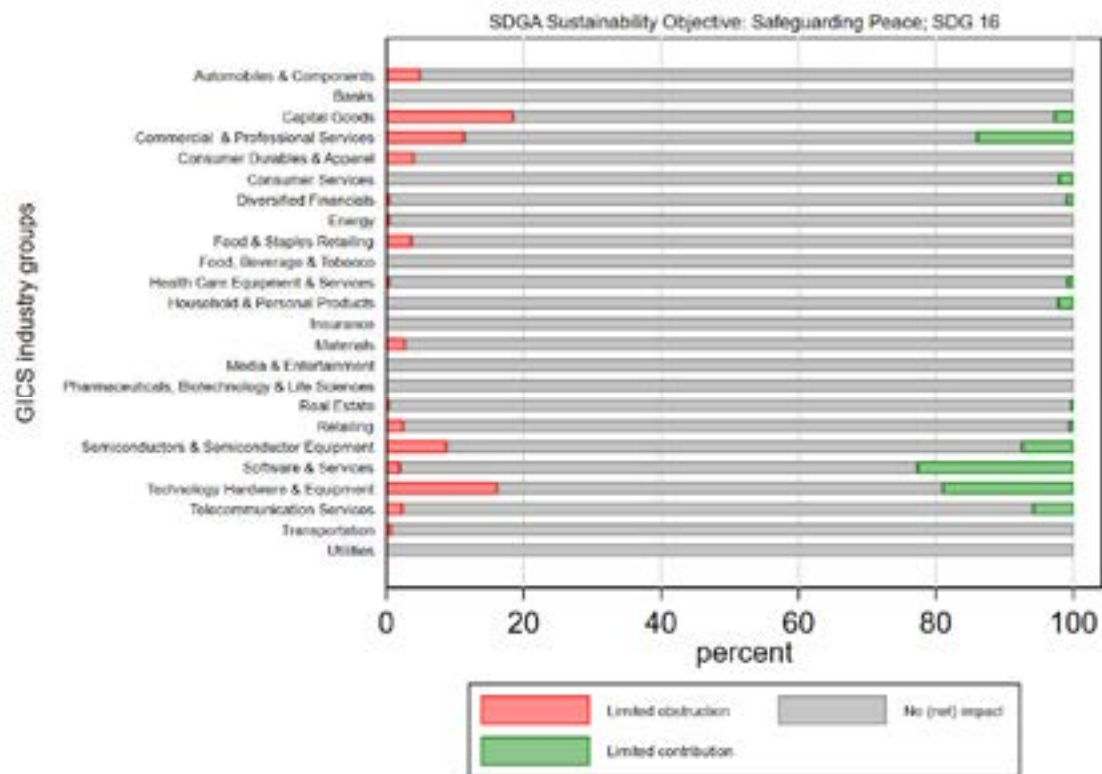
Size	Company	Contribution to objective	Objective score	Explanation
Largest market value	Taiwan Semiconductor Manufacturing Co. Ltd.	Sustainable energy use	3.2	"energy-efficient chips according to Energy Star"
		Mitigating climate change	3.2	
	NVIDIA Corp.	Ensuring health	0.2	"components for diagnostic devices, automotive safety solutions"
		Sustainable energy use	0.3	"cloud computing components"
		Mitigating climate change	0.3	
	Comcast Corp.	Delivering education	0.1	"media content"
		Providing basic services	1.8	"B2C telephony and internet services"
Smallest market value	Enel Generación Chile S.A.	Providing basic services	1.1	"provision of electricity and gas to private customers"
		Sustainable energy use	0.8	Share of net sales from "energy generation (small-scale hydropower, wind), energy generation (large-scale hydropower)" outweighs share of net sales from "energy generation based on coal and oil"
		Mitigating climate change	0.8	
	China Everbright Water Ltd.	Ensuring health	5	"water and wastewater treatment services"
		Providing basic services	1.5	"water and wastewater treatment services for private customers"
		Conserving water	10	"water and wastewater treatment services"
	Infigen Energy Ltd.	Contributing to sustainable energy use	10	"renewable energy generation (wind power)"
		Mitigating climate change	10	

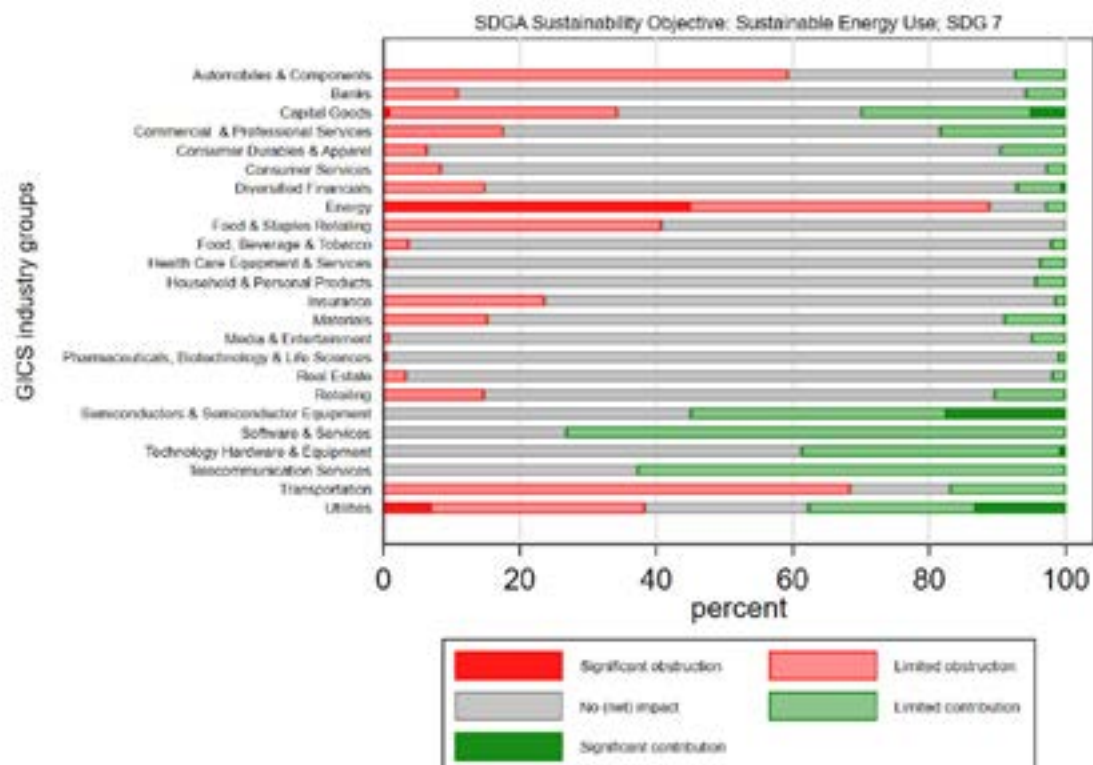
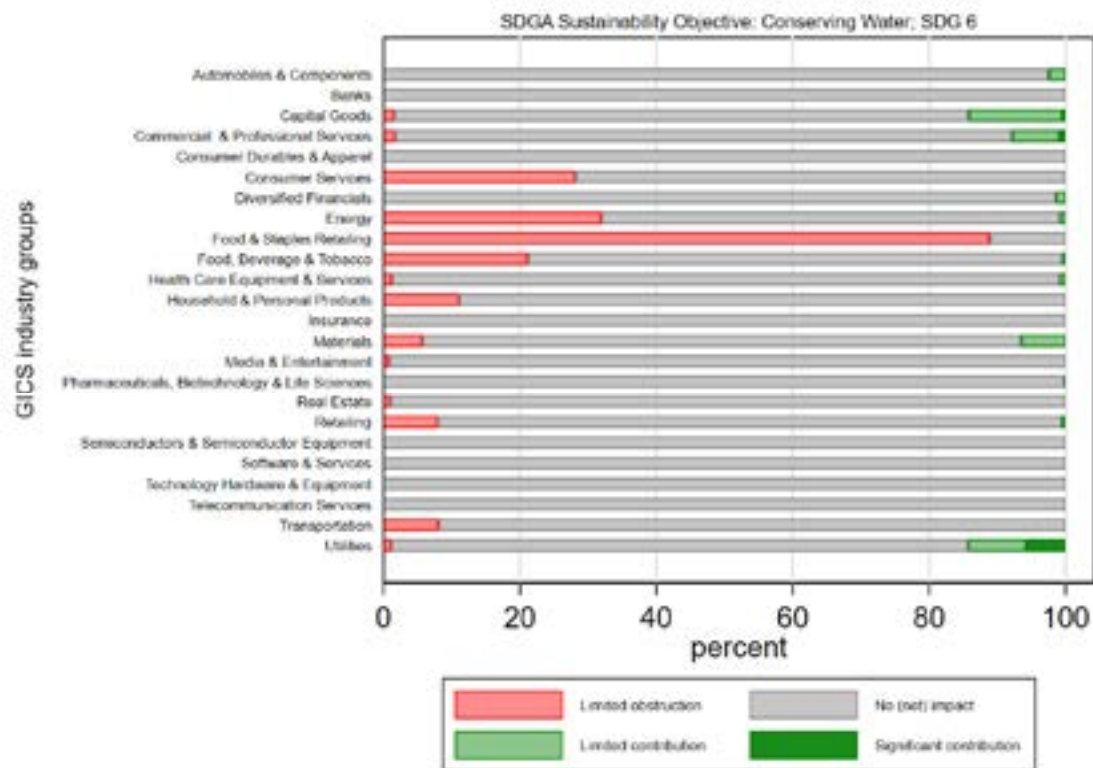
Figure A1: ISS SDG SA across industries

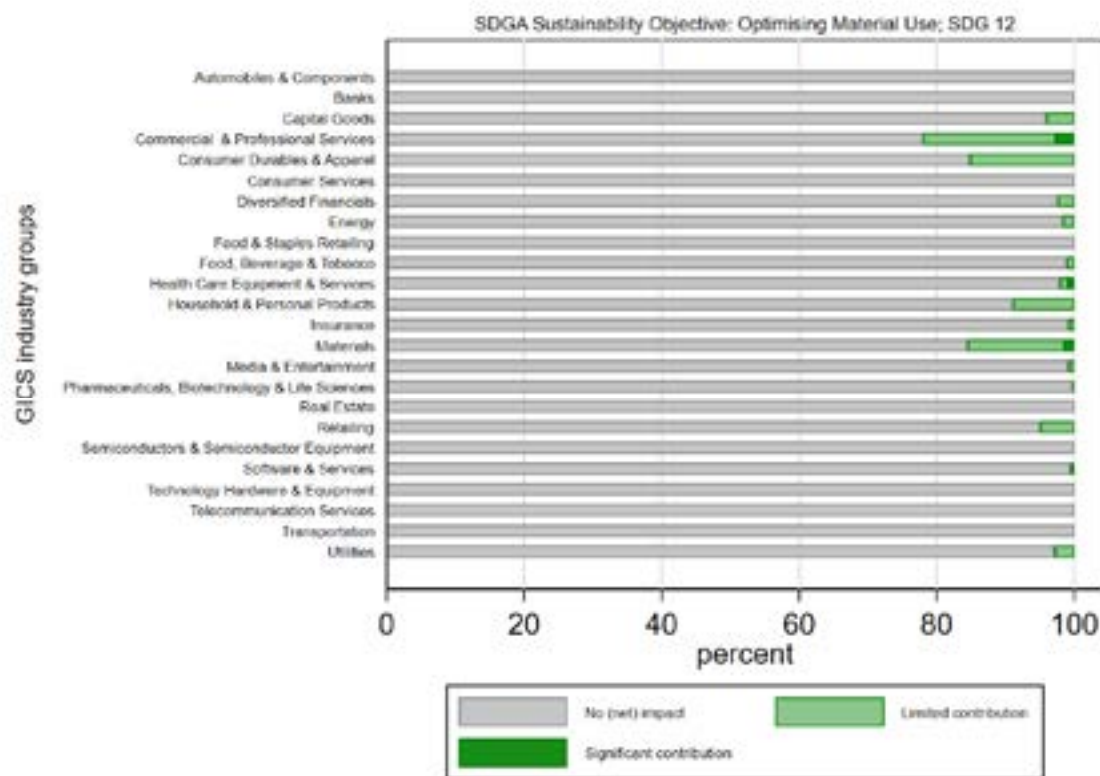
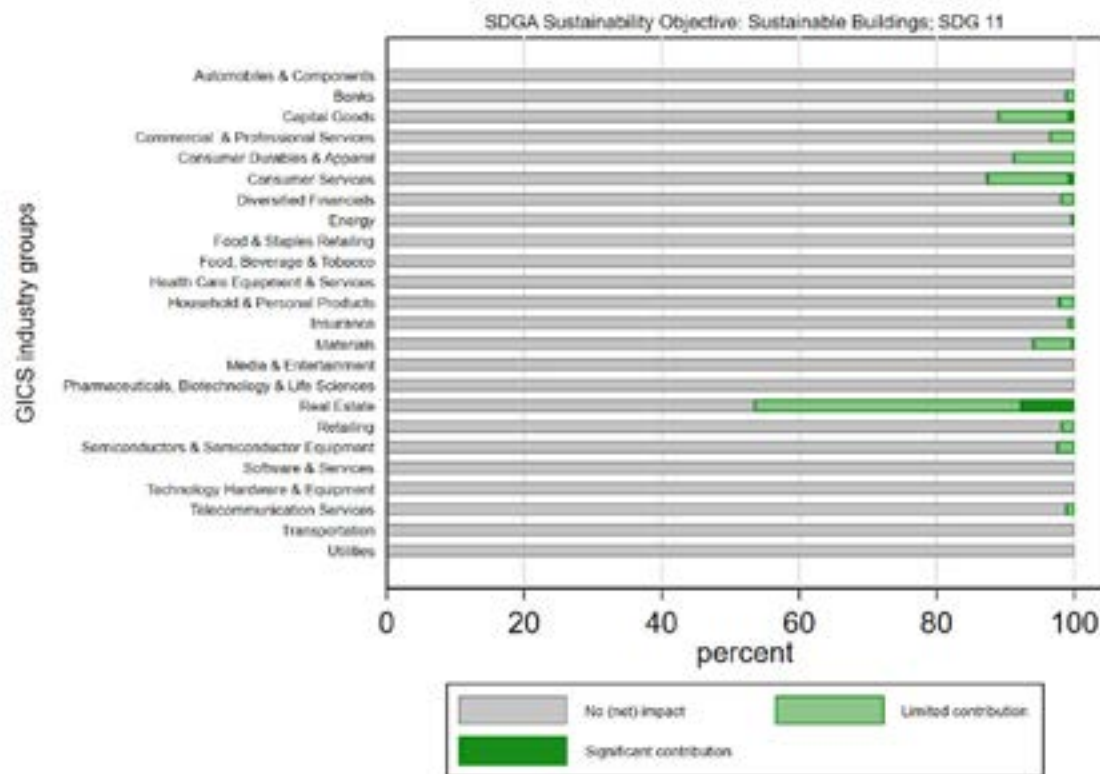


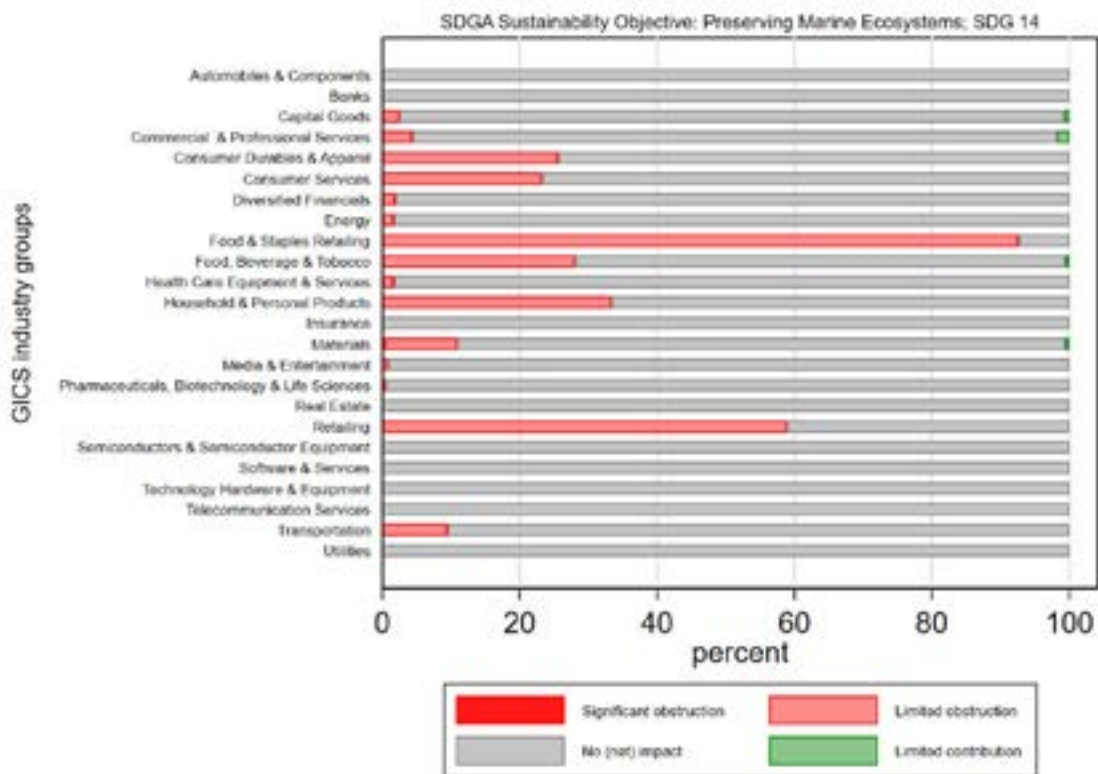
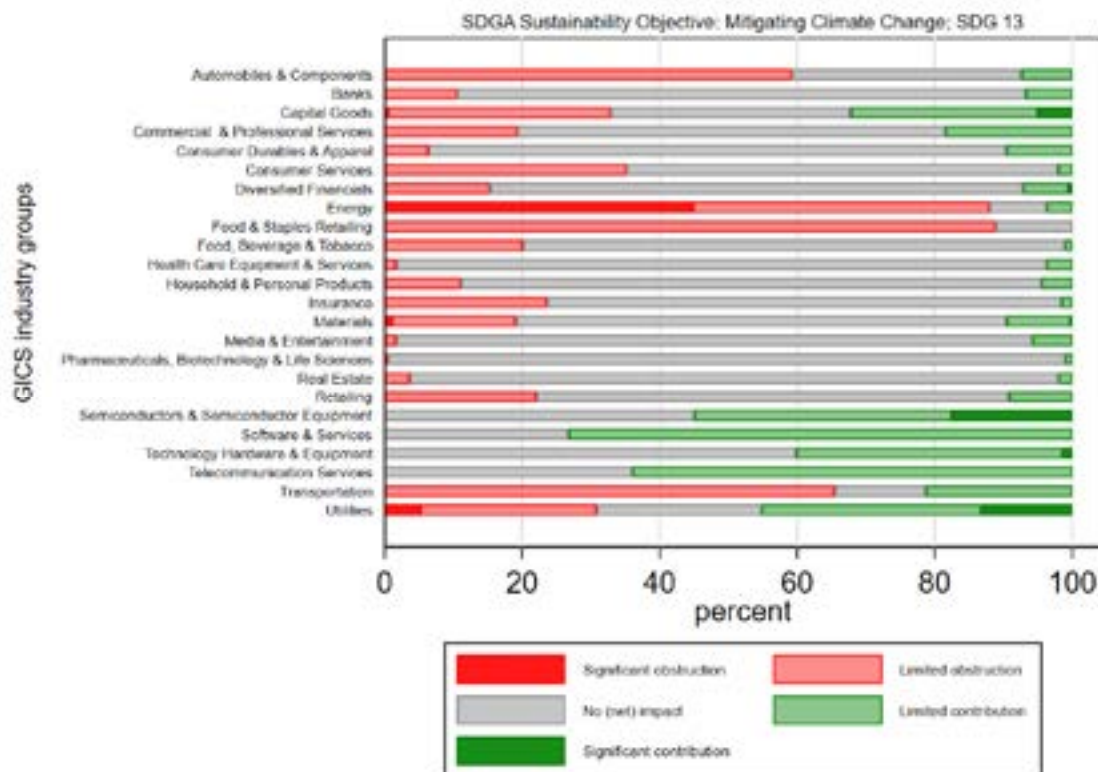












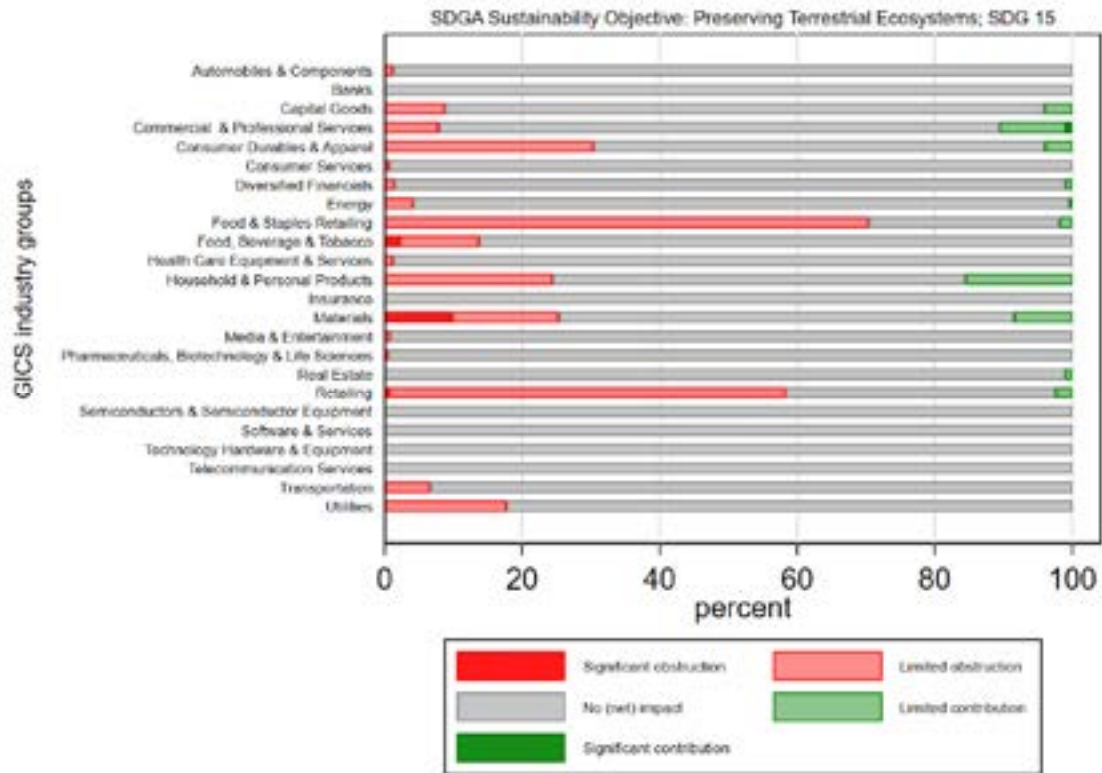
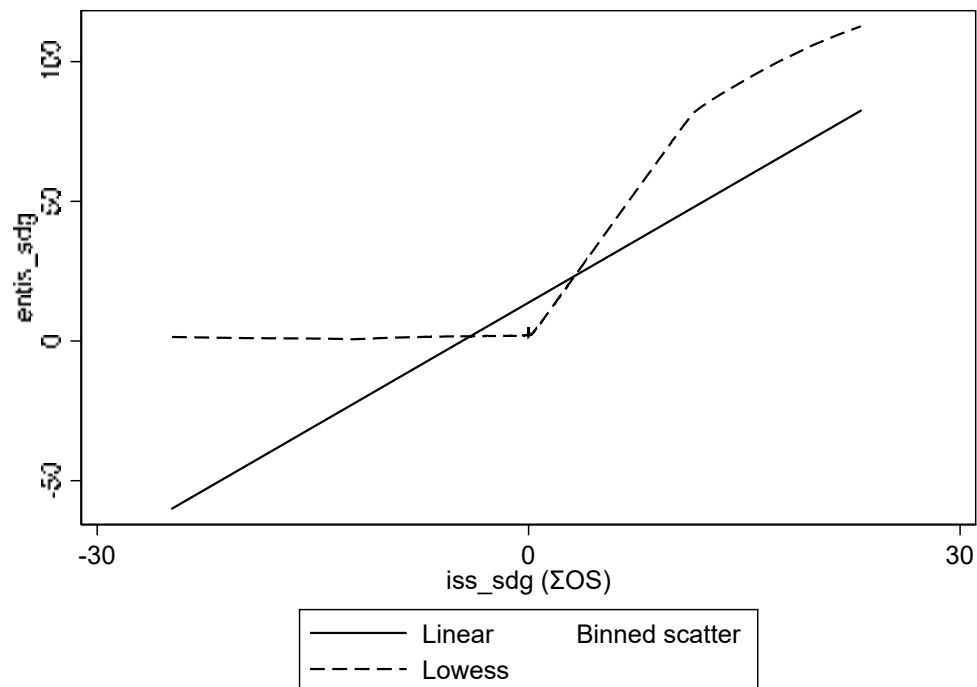
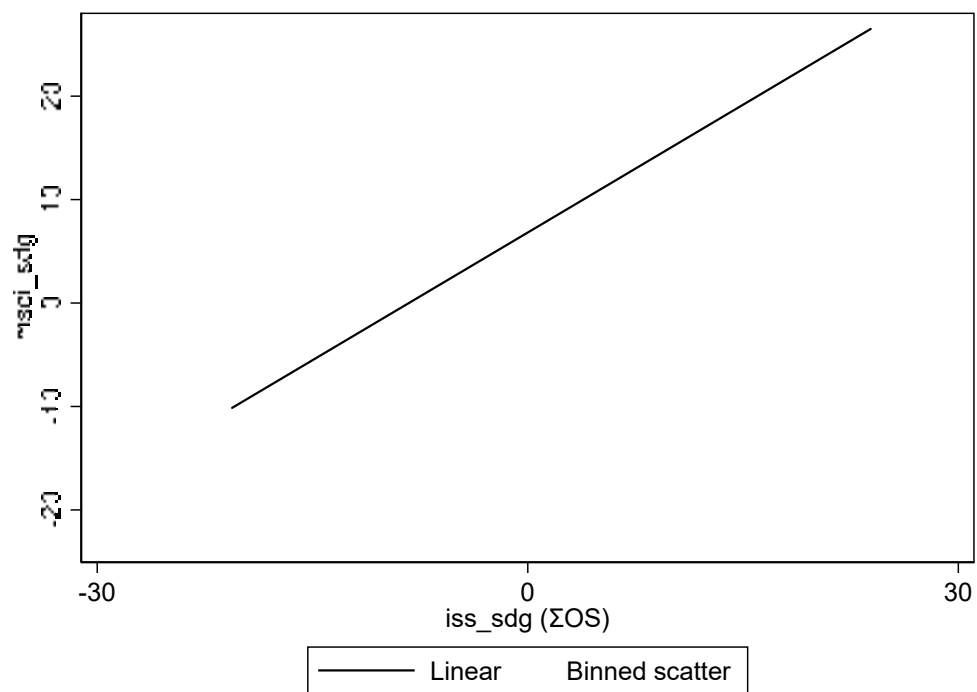
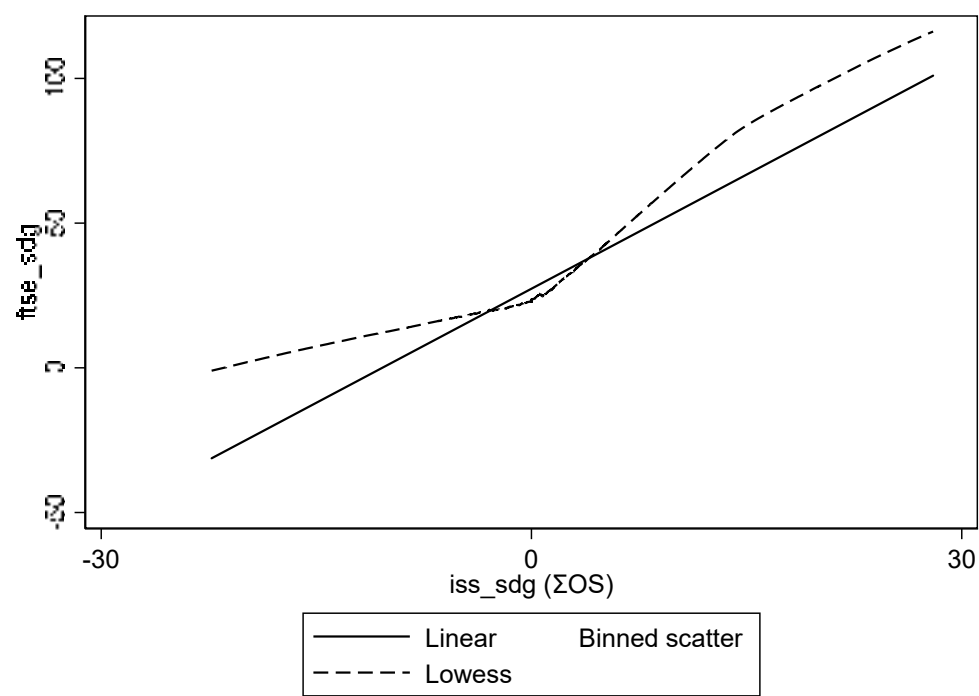
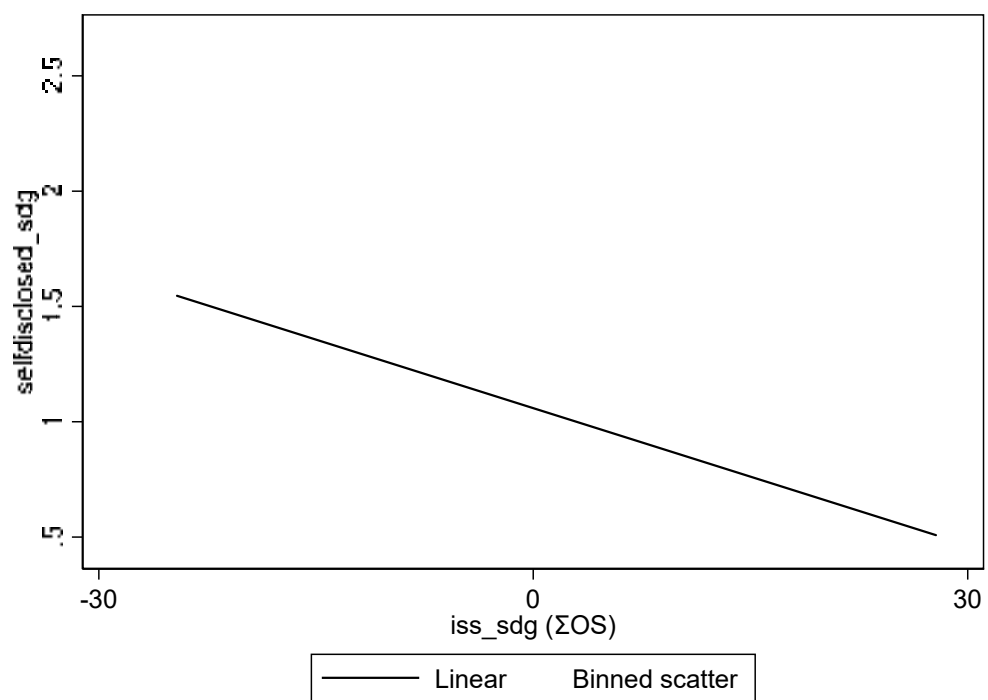


Figure A2: Binned scatterplots between SDG ratings based on products/ services

For a descriptive analysis of the relationship between the two SDG ratings, we use a binned scatterplot.







References

- Berg, F., Koelbel, J. F., & Rigobon, R. (2020). Aggregate Confusion: The Divergence of ESG Ratings. *SSRN Electronic Journal*, 1–64.
- BlackRock (2020). Invest with Impact. Retrieved from <https://www.blackrock.com/us/individual/literature/whitepaper/public-equities-impact-investing-en-us.pdf>
- BNP (2019). BNP Paribas Index Index Methodology Supplement BNP Paribas Equity Global Goals World NTR Index. Retrieved from https://equityworldglobalgoals.bnpparibas.com/wp-content/uploads/bnpiggnw_ims_final_211019.pdf
- BNP (2021). Equity Global Goals World Strategy. Retrieved from <https://equityworldglobalgoals.bnpparibas.com/index-performance-and-composition/>
- Busch, T., Bruce-Clark, P., Derwall, J., Eccles, R., Hebb, T., Hoepner, A., . . . Weber, O. (2021). Impact investments: a call for (re)orientation. *SN Business & Economics*, 1(2). <https://doi.org/10.1007/s43546-020-00033-6>
- Cereola, S. J., Nichols, N. B., & Street, D. L. (2017). Geographic segment disclosures under IFRS 8: Changes in materiality and fineness by European, Australian and New Zealand blue chip companies. *Research in Accounting Regulation*, 29(2), 119–128. <https://doi.org/10.1016/j.racreg.2017.09.003>
- Chatterji, A. K., Durand, R., Levine, D. I., & Touboul, S. (2016). Do ratings of firms converge? Implications for managers, investors and strategy researchers. *Strategic Management Journal*, 37(8), 1597–1614. <https://doi.org/10.1002/smj.2407>
- Chen, T., Dong, H., & Lin, C. (2020). Institutional shareholders and corporate social responsibility. *Journal of Financial Economics*, 135(2), 483–504. <https://doi.org/10.1016/j.jfineco.2019.06.007>
- Deloitte (2006). Deloitte comment letter on ED 8 ‘Operating Segments’. Retrieved from <https://www.iasplus.com/en/publications/global/comment-letters/2006/pub1044>
- Dorfleitner, G., Halbritter, G., & Nguyen, M. (2015). Measuring the level and risk of corporate responsibility – An empirical comparison of different ESG rating approaches. *Journal of*

Asset Management, 16(7), 450–466. <https://doi.org/10.1057/jam.2015.31>

- Dorfleitner, G., Kreuzer, C., & Sparrer, C. (2020). ESG controversies and controversial ESG: about silent saints and small sinners. *Journal of Asset Management*, 21(5), 393–412. <https://doi.org/10.1057/s41260-020-00178-x>
- Dyck, A., Lins, K. V., Roth, L., & Wagner, H. F. (2019). Do institutional investors drive corporate social responsibility? International evidence. *Journal of Financial Economics*, 131(3), 693–714. <https://doi.org/10.1016/j.jfineco.2018.08.013>
- Ferrell, A., Liang, H., & Renneboog, L. (2016). Socially responsible firms. *Journal of Financial Economics*, 122(3), 585–606. <https://doi.org/10.1016/j.jfineco.2015.12.003>
- Flammer, C. (2021). Corporate green bonds. *Journal of Financial Economics*. Advance online publication. <https://doi.org/10.1016/j.jfineco.2021.01.010>
- Garcia, A. S., Mendes-Da-Silva, W., & Orsato, R. J. (2017). Sensitive industries produce better ESG performance: Evidence from emerging markets. *Journal of Cleaner Production*, 150, 135–147. <https://doi.org/10.1016/j.jclepro.2017.02.180>
- Gasser, S. M., Rammerstorfer, M., & Weinmayer, K. (2017). Markowitz revisited: Social portfolio engineering. *European Journal of Operational Research*, 258(3), 1181–1190. <https://doi.org/10.1016/j.ejor.2016.10.043>
- GIIN (2020). Annual Impact Investor Survey. Retrieved from <https://thegiin.org/research/publication/impinv-survey-2020>
- Gillan, S. L., Koch, A., & Starks, L. T. (2021). Firms and social responsibility: A review of ESG and CSR research in corporate finance. *Journal of Corporate Finance*, 66, 101889. <https://doi.org/10.1016/j.jcorpfin.2021.101889>
- GISD (2020a). Definition of Sustainable Development Investing. Retrieved from <https://www.gisdalliance.org/sites/default/files/2020-08/SDI%20Definition%20-%20Final%202020%2006%2004.pdf>
- GISD (2020b). Renewed, Recharged and Reinforced. Retrieved from <https://www.un.org/development/desa/financing/document/renewed-recharged-and-reinforced-urgent-actions-harmonize-and-scale-sustainable-finance>
- ISS ESG (2020). SDG Solutions Assessment. Retrieved from <https://www.issgovernance.com/esg/impact-un-sdg/sustainability-solutions-assessment/>
- Laufer, W. S. (2003). Social Accountability and Corporate Greenwashing. *Journal of Business Ethics*, 43(3), 253–261. <https://doi.org/10.1023/A:1022962719299>
- Liang, H. A., & Renneboog, L. U. (2017). On the Foundations of Corporate Social Responsibility.

The Journal of Finance, 72(2), 853–910. <https://doi.org/10.1111/jofi.12487>

Lins, K. V., Servaes, H., & Tamayo, A. N. (2017). Social Capital, Trust, and Firm Performance: The Value of Corporate Social Responsibility during the Financial Crisis. *The Journal of Finance*, 72(4), 1785–1824. <https://doi.org/10.1111/jofi.12505>

McKinsey (2021). A year of disruption in the private markets. Retrieved from [https://www.mckinsey.com/~media/mckinsey/industries/private equity and principal investors/our insights/mckinseys private markets annual review/2021/mckinsey-global-private-markets-review-2021-v3.pdf](https://www.mckinsey.com/~media/mckinsey/industries/private%20equity%20and%20principal%20investors/our%20insights/mckinseys%20private%20markets%20annual%20review/2021/mckinsey-global-private-markets-review-2021-v3.pdf)

Morningstar (2021a). Construction Rules for the Morningstar® Societal Development Index. Retrieved from https://assets.contentstack.io/v3/assets/bltabf2a7413d5a8f05/blt16cde72ba7480ec3/6062f06c5ec3360f1aab4530/20210330_Morningstar_Societal_Development_Index_Rulebook.pdf

Morningstar (2021b). European Sustainable Funds Landscape. Retrieved from https://www.morningstar.com/content/dam/marketing/emea/uk/European_ESG_Fund_Landscape_2020.pdf

Morningstar (2021c). Morningstar Affirms Integrity of ESG Research and Ratings.

Morningstar (2021d). Morningstar Societal Development GR USD. Retrieved from <https://doc.morningstar.com/LatestDoc.aspx?ClientId=morningstarindexes&key=-2726f02984615a10&documenttype=124&sourceid=220&investmentid=f000011078>

MSCI (2017). MSCI ACWI Sustainable Impact Index. Retrieved from https://www.msci.com/eqb/methodology/meth_docs/MSCI_ACWI_Sustainable_Impact_Index_Sep2017.pdf

MSCI (2021a). MSCI ACWI Sustainable Impact Index. Retrieved from <https://www.msci.com/documents/10199/6d2b3e68-90e0-448e-bd52-eaf0397539d1>

MSCI (2021b). MSCI ESG Ratings. Retrieved from <https://www.msci.com/documents/1296102/21901542/MSCI+ESG+Ratings+Brochure-cbr-en.pdf>

Poddig, T., Varmaz, A., & Fieberg, C. (2015). *Computational Finance: Eine Matlab, Octave und Freemat basierte Einführung* (neue Ausg). Bad Soden/Ts.: Uhlenbruch.

UN PRI (2018). Impact Investing Market Map. Retrieved from <https://www.unpri.org/download?ac=5426>

Refinitiv (2021). Environmental, Social and Governance (ESG) Scores from Refinitiv. Retrieved from https://www.refinitiv.com/content/dam/marketing/en_us/documents/methodology/refinitiv-esg-scores-methodology.pdf

Saadaoui, K., & Soobaroyen, T. (2018). An analysis of the methodologies adopted by CSR rat-

ing agencies. Sustainability Accounting, Management and Policy Journal, 9(1), 43–62. <https://doi.org/10.1108/SAMPJ-06-2016-0031>

Sifma (2020). 2020 Capital Markets Fact Book. Retrieved from <https://www.sifma.org/wp-content/uploads/2020/09/US-Fact-Book-2020-SIFMA.pdf>

Solactive (2020a). Index Guideline Solactive ISS SDG Aligned Index Series. Retrieved from <https://solactive.com/downloads/Guideline-Solactive-SDG.pdf>

Solactive (2020b). Index Guideline Solactive ISS SDG Leaders Index Series. Retrieved from <https://solactive.com/downloads/Guideline-Solactive-SDGLEAD.pdf>

Solactive (2020c). Solactive Global UN Sustainable Development Goals Index. Retrieved from https://solactive.com/downloads/SOUNSDG_Guideline.pdf

Solactive (2021a). Factsheet Solactive Global UN Sustainable Development Goals Index. Retrieved from https://www.solactive.com/wp-content/uploads/solactiveip/en/Factsheet_DE000SLA9KU1.pdf

Solactive (2021b). Factsheet Solactive ISS SDG Aligned Global Markets All Cap Index PR. Retrieved from https://www.solactive.com/wp-content/uploads/solactiveip/en/Factsheet_DE000SL0BDU4.pdf

Solactive (2021c). Factsheet Solactive ISS SDG Leaders Index PR. Retrieved from https://www.solactive.com/wp-content/uploads/solactiveip/en/Factsheet_DE000SL0BDX8.pdf

Sustainalytics (2021a). Controversies Research. Retrieved from <https://www.sustainalytics.com/investor-solutions/esg-research/controversies-research>

Sustainalytics (2021b). ESG Risk Ratings - Methodology Abstract. Retrieved from <https://connect.sustainalytics.com/esg-risk-ratings-methodology>

Sustainalytics (2021c). Global Standards Screening. Retrieved from <https://www.sustainalytics.com/investor-solutions/esg-research/esg-screening/global-compact-norms-based-screening#:~:text=Sustainalytics'%20Global%20Standards%20Screening%20assesses,of%20international%20norms%20and%20standards.>

UN (2019). Citing \$2.5 Trillion Annual Financing Gap during SDG Business Forum Event, Deputy Secretary-General Says Poverty Falling Too Slowly. Retrieved from <https://www.un.org/press/en/2019/dsgsm1340.doc.htm>

Van Duuren, E., Plantinga, A., & Scholtens, B. (2016). ESG Integration and the Investment Management Process: Fundamental Investing Reinvented. *Journal of Business Ethics*, 138(3), 525–533. <https://doi.org/10.1007/s10551-015-2610-8>

Varmaz, A., Fieberg, C., & Poddig, T. (2021). Portfolio optimization for sustainable invest-

ments. SSRN Electronic Journal. Advance online publication. <https://doi.org/10.2139/ssrn.3859616>

Wettstein, F., Dey, P., Schaefers, K., & Bahlmann, J. M. (2019). Impact Investing: Konzept, Spannungsfelder und Zukunftsperspektiven Eine Orientierung für private und institutionelle Investoren.

World Benchmarking Alliance (2019). Measuring what matters most: Seven systems transformations for benchmarking companies on the SDGs. Retrieved from <https://assets.worldbenchmarkingalliance.org/app/uploads/2020/09/WBA-sevensystemstransformations-report.pdf>

