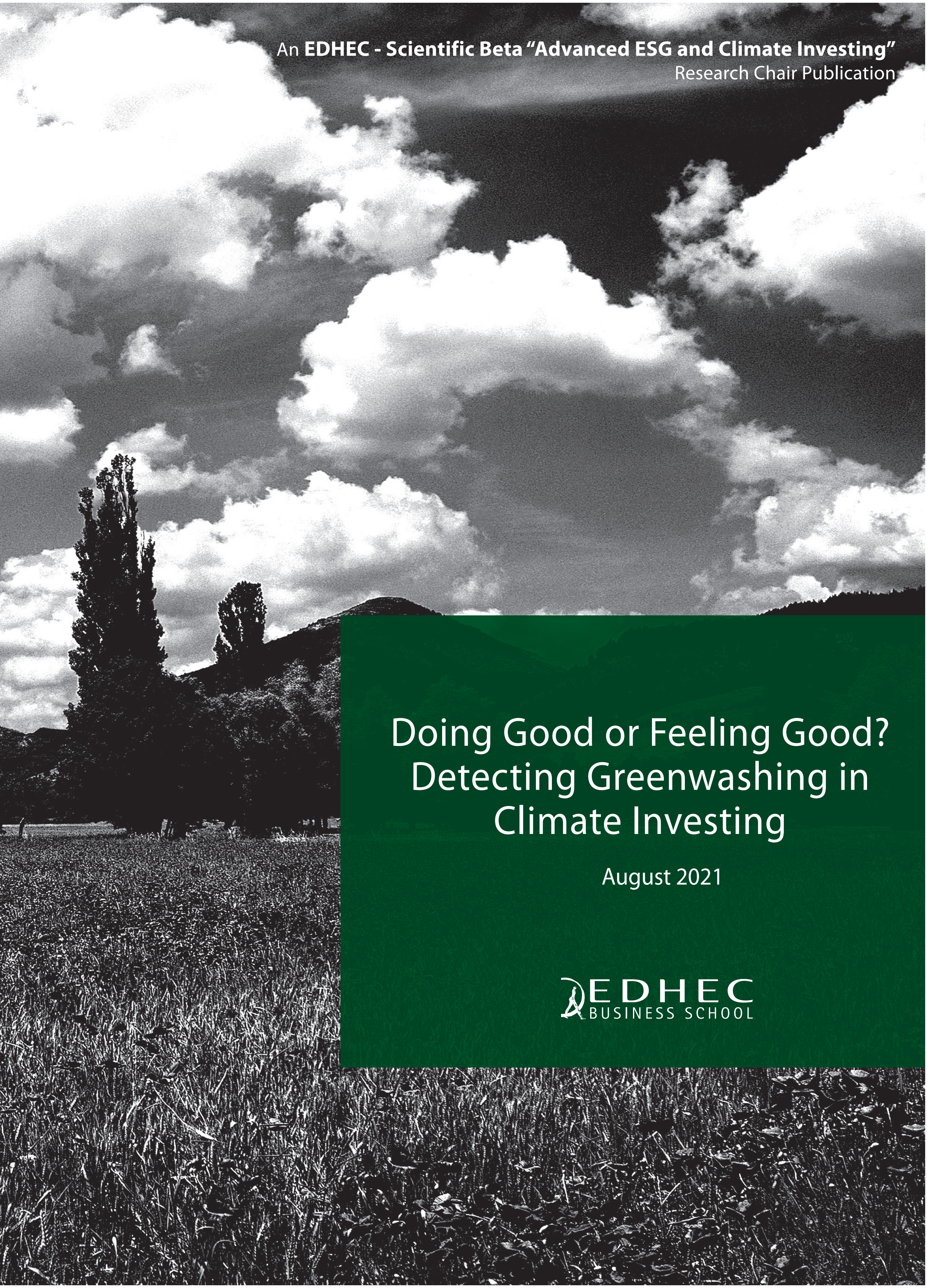
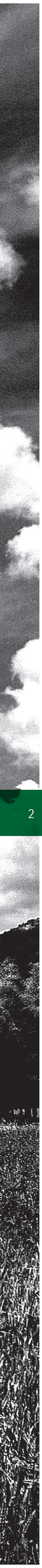
An **EDHEC - Scientific Beta "Advanced ESG and Climate Investing"**
Research Chair Publication



Doing Good or Feeling Good? Detecting Greenwashing in Climate Investing

August 2021

EDHEC BUSINESS SCHOOL



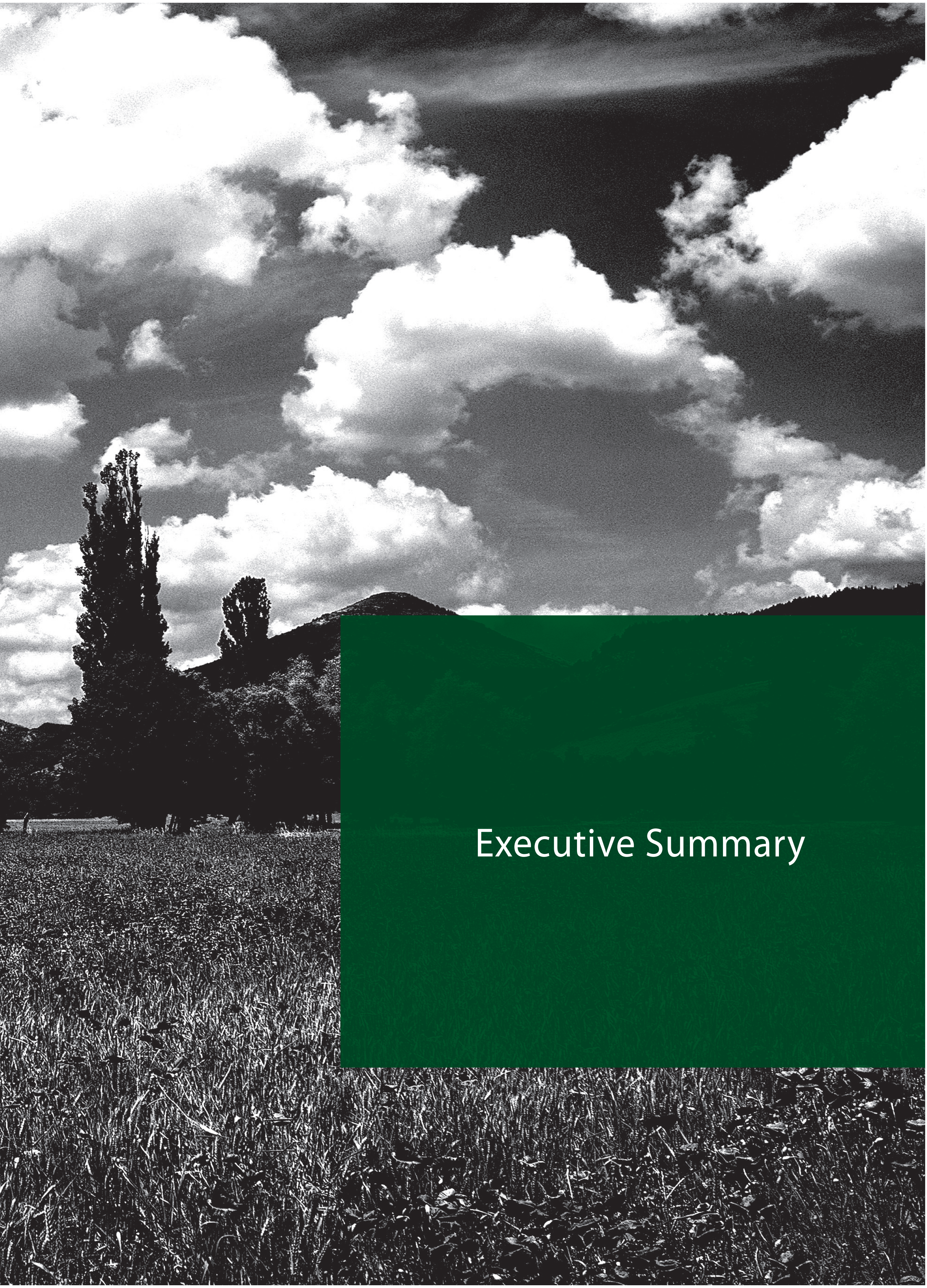
The present document was prepared as part of research conducted by EDHEC and does not engage the responsibility of Scientific Beta. It is an EDHEC Business School publication for which Scientific Beta did not have a right of review.
The authors are grateful for financial support from the EDHEC Scientific Beta "Advanced ESG and Climate Investing" Research Chair.
Printed in France, August 2021. Please refer to the disclaimer at the end of this document.

About the Authors

Noël Amenc, PhD, is Associate Professor of Finance at EDHEC Business School and the founding Chief Executive Officer of Scientific Beta. His concern for bridging the gap between university and industry has led him to pursue a double career in academe and business. Prior to joining EDHEC Business School as founding director of EDHEC-Risk Institute, he was the Director of Research of Misys Asset Management Systems, having previously created and developed a portfolio management software company. He has published numerous articles in finance journals as well as four books on quantitative equity management, portfolio management, performance analysis, and alternative investments. He is a member of the editorial board of the *Journal of Portfolio Management*, associate editor of the *Journal of Alternative Investments*, and member of the advisory board of the *Journal of Index Investing*. He is also a member of the Finance Research Council of the Monetary Authority of Singapore. He was formerly a member of the Consultative Working Group of the European Securities and Markets Authority (ESMA) Financial Innovation Standing Committee and of the Scientific Advisory Council of the AMF (French financial regulatory authority). He holds graduate degrees in economics, finance and management and a PhD in finance.

Felix Goltz, PhD, is is Associate Researcher at EDHEC Business School, Member of the EDHEC-Scientific Beta "Advanced ESG and Climate Investing" Research Chair and Research Director at Scientific Beta. He carries out research in empirical finance and asset allocation, with a focus on alternative investments and indexing strategies. His work has appeared in various international academic and practitioner journals and handbooks. He obtained a PhD in finance from the University of Nice Sophia-Antipolis after studying economics and business administration at the University of Bayreuth and EDHEC Business School.

Victor Liu, CFA, is a Quantitative Analyst at Scientific Beta. He has contributed to the design and documentation of low carbon and ESG indices and supported research and development in ESG data and metrics. Prior to joining Scientific Beta in 2016, he worked in risk analysis and compliance in the financial services industry for a year. He holds a Master of Science in Financial Markets degree from EDHEC Business School.



Executive Summary

Executive Summary

In this study, we identify greenwashing risks in the construction of portfolios that represent popular climate strategies, especially those that correspond to net-zero alignment strategies.

To carry out this analysis, we define key requirements in order for strategies to be consistent with influencing firms to reduce greenhouse gas emissions. Based on stylised equity strategies constructed using firm-level emissions data, we show that commonly-used portfolio construction mechanisms fail to deliver consistency with impact objectives. As a result, the vast majority of institutional funds and mandates that claim to have a positive impact on the climate are exposed to large and obvious greenwashing risks, largely because they exhibit attractive climate metrics at portfolio level through implementation of these flawed strategies. De facto, the investment industry, in spite of its promises, does little to reallocate capital in a direction and in a manner that could incentivise companies to contribute to the climate transition.

Key Indictors of Greenwashing Risks

We differentiate between two types of greenwashing:

• The first, which is better known, is corporate greenwashing, whereby firms advertise environmental credentials for their products and practices (or otherwise seek to shape perceptions) that are materially inflated or even in contradiction to their performance. This type of greenwashing receives considerable attention from all stakeholders (investors, NGOs, regulators) and is widely criticised.

• The second is portfolio greenwashing by the finance industry. Investment managers may claim that their funds produce a positive impact on the environment when in fact they are not managed in a manner that is consistent with promoting such an impact.

A key feature of popular climate strategies is that they improve portfolio greenness scores, such as weighted average emissions. While portfolio greenness scores are displayed extensively to attract investors, increasing a portfolio's score does not in fact encourage firms to reduce emissions, either through direct impact of allocation on cost of capital or a signalling channel. Instead, three main problems[1] may arise when focussing solely on a portfolio greenness score.

• First, climate scores represent at most 12% of the determinants of ESG portfolio stock weights on average.

We assess whether climate strategies can correspond to "closet business-as-usual investing" which, despite displaying higher greenness scores, differs very little from cap-weighted benchmarks. In particular, we will assess what the key determinants of portfolio weights are, and how climate scores impact portfolio weights in relation to other characteristics, such as market capitalisation or general ESG scores. As such, we observe that even though investors and managers communicate extensively on the use of climate data to construct their portfolios, these data represent at most 12%[2] of the determinants of portfolio stock weights on average.

• Second, it is easy to display greenness by under-weighting high emissions sectors.

However, the outputs of these sectors, notably the energy sector, are essential to the functioning of the

1 - An additional issue which we do not pursue in our empirical analysis is that overly ambitious emissions data may lack robustness (see Ducoulombier 2021.)
2 - According to our regression based Weight Determinant Analysis, on average across ten years ending in 2020. The impact of climate scores in percentage range from 6% to 12%. Section 3 contain the details of this analysis.

Executive Summary

economy. The key issue is not how to restrict investment in these industries, but rather, how to make sure that these industries invest in technology that allows them to produce needed goods and services with minimum release of greenhouse gases. This alignment requires highly selective intra-sector capital allocation favouring climate change leaders and incentivising progress across and within sectors. To characterise this second dimension of portfolio greenwashing, we assess whether climate strategies simply underweight such key economic sectors, a choice which would be inconsistent with the promotion of transition. We look at changes in sector allocation over market indices, the contribution of sector weighting decisions to reductions in portfolio climate scores, as well as the weighting decisions of key economic sectors, like electricity, for which the financing of carbon efficiency is key to achieving energy transition for the whole economy.

• **Third, a portfolio's green score does not account for individual firm dynamics.**
Firm-level weighting decisions need to send clear signals to firms' management to motivate them to improve their climate performance. Such clear signals are also important for engagement strategies to be effective. There needs to be a synergistic relationship between portfolio construction and engagement. For example, if an investor holds discussions with a company to try and convince it to increase efforts to mitigate emissions, it would be counterproductive for the effectiveness of such of an engagement for the investor to increase the weight of the company's stock in the portfolio without relevant strings being attached.

To detect how portfolio decisions in climate strategies suffer from blurred signals, we analyse stocks with deteriorating climate scores, and report to what extent climate strategies increase the weight in such deteriorators. We also analyse the extent to which changes in climate scores influence changes in stock weights in climate strategies.

A Taxonomy of Climate Strategies

To carry out our analysis, we have collated the various impact and alignment investment strategies by drawing up a taxonomy that takes into account the various portfolio construction methods that underlie the asset management and climate index offerings. Like any taxonomy, the one proposed in this research allows the multiple climate investing approaches and offerings to be reduced to stylised facts that are representative of key features. It enables conclusions to be drawn that are not only relevant but also robust in order to respond to questions that concern the investment industry as a whole rather than any particular asset manager or index provider.

Although products come in various flavours when it comes to climate metrics, security screenings or input data, we can clearly distinguish two main approaches to stock weighting: a tilting approach and an optimisation based approach.

• The tilting approach consists of taking the market capitalisation weight of a stock and multiplying it by an adjustment factor. In the case of climate strategies the adjustment factor would be based on one or more climate scores representing climate performance. This approach results in post-normalisation

Executive Summary

portfolio weights that are tilted towards climate friendly companies and away from high polluting companies. That is a typical way of constructing portfolios, with the potential to incorporate multiple objectives simultaneously using multiplicative adjustment factors representing each objective.

• The second approach is optimisation based, usually targeting a minimum level of improvement in climate metrics while portfolio weights are optimised to minimise deviation from a market-cap-weighted reference universe. The deviation from the reference universe can be measured as the sum of stock-level active weights or the ex-ante tracking error of the portfolio. This approach would typically achieve portfolio-level metric improvement at low 'cost' in a market-capitalisation-anchored framework, with obvious appeal for investors with tracking error budgets.

The other dimension of interest is the distinction between strategies that are concerned solely with climate and strategies that conflate climate considerations with general ESG considerations. If investors wish to prioritise climate change mitigation, integrating general ESG considerations could potentially lead to mixed signals when climate performance and general ESG performance diverge. Our taxonomy thus includes four strategy types: climate tilting strategies, mixed climate and ESG tilting strategies, climate optimised strategies and mixed climate and ESG optimised strategies.

We construct stylised strategies in developed equity markets to reflect these strategies, drawing on firm-level greenhouse gas emissions data. Stylised strategies reflect the main weighting mechanisms used in commercial climate strategies, not the commercial products themselves. The advantage of stylised strategies lies in the replicability and tractability of our results. To ensure the robustness of our conclusions, independently of a particular emissions metric, we consider eight different metrics, using different emissions scopes and different normalisations of emissions by firm size.

Popular Weighting Mechanisms in Climate Strategies do not align with Impact Objectives

We test whether the stylised climate strategies fulfil the three impact criteria mentioned above. Across 32 specifications of stylised strategies that build on commonly-used weighting schemes and greenhouse gas emissions data, we find that climate strategies are inconsistent with the objective of influencing firms to reduce their emissions.

• First, we find that climate scores only have a marginal impact on weights. Conducting a regression-based analysis of determinants of stock weights in the strategies, we find that weights are driven mainly by other aspects, such as market capitalisation. Across strategies focusing on climate, the climate scores only account for 12% of differences in weights across stocks. In contrast, market capitalisation accounts for 88% of the differences in weights in these strategies. Thus, the impact of market capitalisation overwhelms any climate consideration. Mixing in ESG scores makes climate scores even less impactful. In mixed objective strategies, the main driver remains market capitalisation, with 73% on average, followed by the ESG score, with 21% on average, leaving a mere 6% to the climate score. Indeed, climate strategies, just like business-as-usual strategies, are mostly influenced by the market capitalisation of stocks. The climate score plays second fiddle at best.

Executive Summary

• Second, strategies are relatively insensitive in their allocation decisions to the dynamics of corporate climate performance. Climate strategies display significant weight increases in stocks with deteriorating climate score over time ("deteriorators"). We observe that on average around 35% of deteriorators are rewarded with an increase in weight across the strategies we analyse. This percentage increases to 41% when using popular emissions metrics that do not normalise by firm value, such as carbon intensity. We find an even starker conflict with consistent signalling from a regression-based analysis. The analysis indeed shows that weight changes do not have any statistically significant dependence on climate score changes. This suggests that strategies are basically indifferent to the evolution of climate performance and thus fail to send clear signals to companies. When assessing methodologies from commercial index providers, we do not find any rule that would explicitly address the problem of increasing weights of deteriorators.

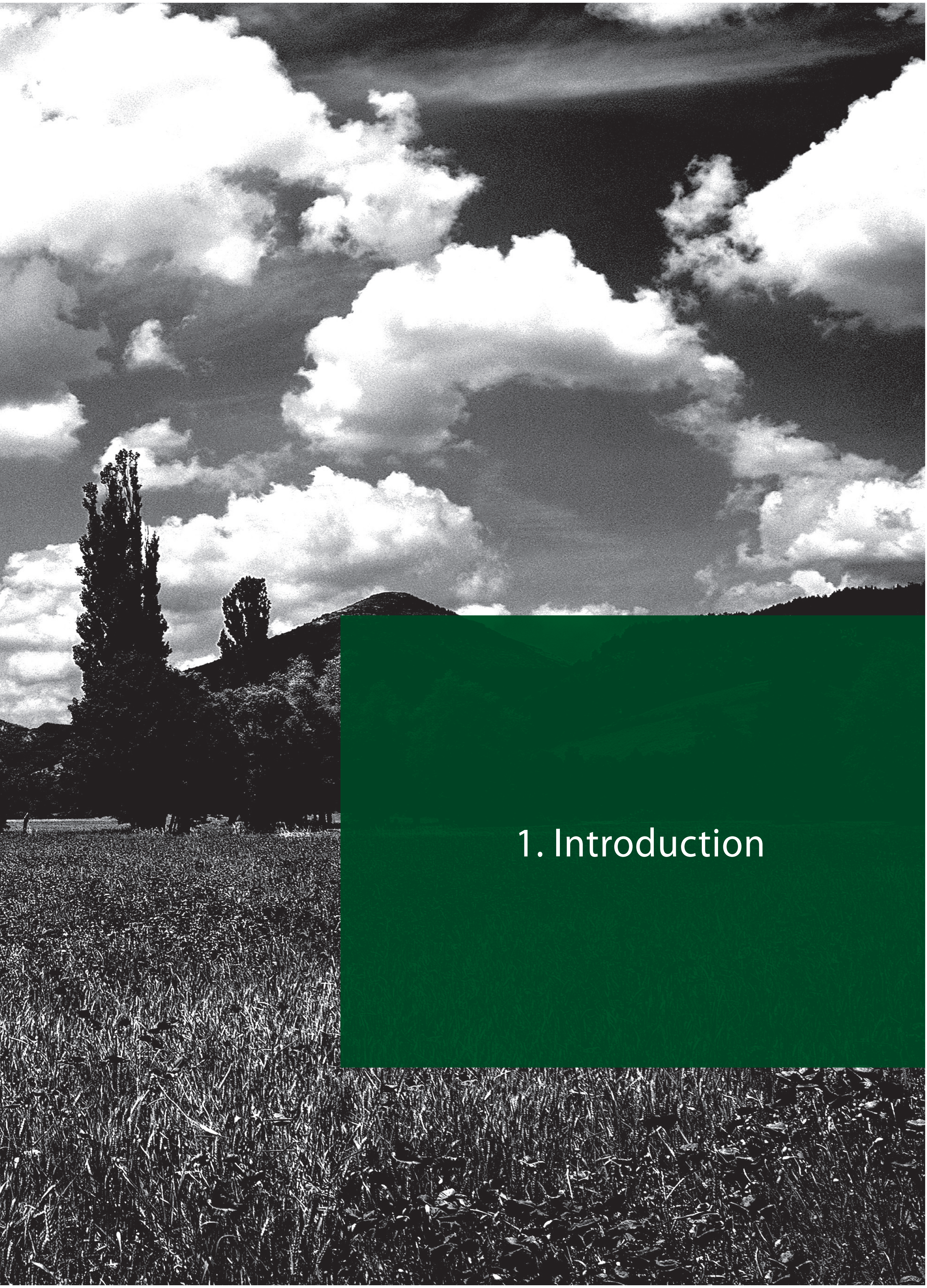
• Third, a key mechanism creating the optical effect of improved portfolio green scores of climate strategies is simple underweighting of essential sectors with high emissions. We find that climate strategies underweight essential sectors such as electricity in a drastic way, by up to 91%. While this allows good portfolio green scores to be displayed, it will be less easy to greenify the economy by doing away with electricity. We also find that sector constraints in climate indices are too loose to safeguard against underfunding of the electricity sector.

We conduct extensive robustness checks and confirm that introducing additional elements of investment practice does not alter our diagnosis. Incorporating emissions trajectories and constraints on high climate impact sectors, as required by the EU regulation for Paris-Aligned Benchmarks, does not address any of the problems we document. Using commercial ratings for environmental or climate scores, we find that the main problems emphasised in stylised strategies prevail, though at a more moderate level.

Ultimately, we can conclude from the analyses carried out that, for want of an appropriate strategy and despite considerable investment (that justifies higher fees) in producing and qualifying climate performance data, the investment industry's current solution has yet to deliver on the committed ambitions and a change is needed.

Our analysis is easily replicable for any investor who has access to the portfolio weights of a climate strategy and firm-level data for their preferred climate score. When conducting due diligence, institutional investors and their consultants need to pay attention to these greenwashing risks.

As part of this consideration and to favour the fight against portfolio greenwashing, we suggest that when climate considerations represent less than 50% of the determinants of the weight of the stocks in a portfolio that is presented as promoting the transition to a low carbon or net-zero economy, then this portfolio should be considered to be at a significant risk of greenwashing and should not be permitted to claim that it is climate-friendly or aligned with net-zero ambitions.



1. Introduction

1. Introduction

A key goal behind climate investing is that investors seek to have the real-world impact of reducing greenhouse gas (GHG) emissions through their investments. The marketing material of product providers and mission statements of investor alliances often take the view that portfolio decarbonisation, i.e., holding portfolios of greener stocks, will automatically ensure this impact. However, achieving impact through investments is not so simple; we need to ask which precise mechanisms create such an impact and how we can align portfolios so that they exploit these mechanisms. Based on analysing impact mechanisms, we propose three key criteria that are necessary conditions for impact. We then assess whether climate strategies that employ popular weighting schemes fulfil these criteria. Our results suggest that common construction methods for climate investing strategies are not able to address even the basic requirements for impact.

Investor Objectives in Climate Investing

Greenhouse gas (GHG) emissions of firms produce a negative externality because they contribute to climate change. Nordhaus (2019) emphasises that "*climate change threatens, in the most extreme scenarios, to return us economically whence we came*". Institutional investors have tried to incorporate climate considerations into their equity portfolios through low carbon strategies. An example of an investor initiative that aims to reduce holdings in shares of carbon-intensive companies is the Portfolio Decarbonization Coalition (PDC), which was created in 2016 and now represents more than USD800bn in assets with a low carbon objective.

There are different motivations for investors considering low carbon strategies.

• First, some investors want to obtain non-pecuniary benefits from their investments. They may obtain benefits by aligning investments with their values and avoiding firms that emit a lot of greenhouse gases. Another way of obtaining non-pecuniary benefits from low carbon investing is to weigh on the growth of firms and/or influence them to change their practices by directing capital towards climate change leaders.

• Second, some investors are looking for pecuniary benefits from climate investing. For example, avoiding exposure to high emitters should tend to reduce exposure to transition risks from the rise of carbon costs and emissions constraints. Another example of a pecuniary motivation is that low carbon investing may provide positive alpha and thus boost performance, for example in the case where markets under-price climate risks.

Some of these motivations do not require investors to behave any differently from standard investors. For example, the second motivation, outperformance, does not distinguish climate investing from standard investing in terms of investor objectives. Traditionally, investors are concerned with maximising their risk-adjusted return. Similarly, the first motivation, risk management, is present for business-as-usual investors. In fact, identifying relevant risk factors and managing exposure is one of the fundamental tasks when building optimal portfolios (see Merton, 1969). In order to make decisions to maximise risk-adjusted return and manage the risks of their investment portfolio, business-as-usual

1. Introduction

investors should consider all relevant information; this will include information not just on current company financial ratios and past returns, but also more qualitative information such as management quality, political risks, technology risks, natural disaster risk, and also climate risk. In short, business-as-usual investors will consider those climate issues that are relevant for risk and return, even if they do not care about the climate per se (financial materiality perspective).

Other motivations for climate investing only exist for investors that are different from business-as-usual investors. Alignment with values is not an issue for business-as-usual investors who only care about financial value. However, there is ample evidence that investors derive utility not only from risk-adjusted returns, but also from the non-pecuniary aspects of their investments. For example, holding assets of firms that are high polluters may generate disutility for an investor who cares about the environment. Likewise, investors may be concerned not just with alignment of their investments with their values but with social or environmental impacts of their investment activity. In fact, that investments will have impact is a key idea behind institutional investor campaigns and alliances. For example, the Portfolio Decarbonization Coalition (PDC) states that its mission is to "*drive GHG emissions reductions on the ground by mobilizing a critical mass of institutional investors committed to gradually decarbonizing their portfolios*". This objective of impact, not just value alignment, is common to the most important and most recent investor initiatives on climate investing. We turn to a review of recent developments on institutional investor initiatives working towards climate impact to illustrate this point.

Investor Coalitions on Climate Change Emphasise Impact Objectives

There are two recent investor initiatives in climate change which stress impact objectives. Our objective is not to provide a comprehensive review of the alphabet soup of different investor initiatives. Instead, we focus on these two, namely the Paris-Aligned Investment Initiative (PAII) and the Net-Zero Asset Owner Alliance.

The PAII brings together investor network organisations from four continents to examine how investors can align their portfolios and activities with the goals of the Paris Agreement. Joining its initiator, the Europe-dominated Institutional Investors Group on Climate Change (IIGCC), are the North-American sustainability pioneer Ceres, the Asia Investment Group on Climate Change (AIGCC) and Australasia's Investor Group on Climate Change (IGCC).[3]

In March 2021, the PAII unveiled the first version of the "Net Zero Investment Framework Implementation Guide" ("the Framework"). In June 2021, 44 investors representing over USD9tn in assets (including 28 institutional investors with close to USD2tn in assets) were using (or had committed to use) this Framework.

Another initiative, the Net-Zero Asset Owner Alliance was founded at the UN Secretary General's Climate Action Summit by a small group of large European and North-American asset owners[4] in September 2019. By end June 2021, this initiative had grown into a group of 42 institutional investors straddling four continents and representing close to USD7tn of assets under management.

3 - As of March 2021, the 275+ IIGCC membership is made up mainly of large pension funds and asset managers that collectively manage EUR35tn in assets; the CERES investor network welcomes over 180 institutional investors managing over USD30 trillion in assets; AIGCC has 49 asset owner and financial institution members representing over USD13tn and IGCC federates institutional investors and advisors, managing over USD2tn in assets. Together, members of the four investor initiatives behind the Paris aligned investment initiatives oversee assets of USD84tn (using the ECB reference USD-EUR exchange rate from 31 March 2021 and summing the aforementioned amounts across the four investor groups).
4 - Allianz, Caisse des Dépôts, La Caisse de dépôt et placement du Québec (CDPQ), Folksam Group, PensionDanmark, and SwissRe.

1. Introduction

Its members are committed to transitioning their investment portfolios to net-zero emissions by 2050 (consistent with a 1.5°C scenario), and regularly reporting on progress. In January 2021, the Alliance released the "Inaugural 2025 Target Setting Protocol" (the "Protocol").

The Framework and the Protocol should be seen as complementary rather than competing. The Protocol builds on the work of the Framework and underlines that the PAII work on assessing asset-level alignment or potential to transition is aligned with its own criteria and encourages Alliance member to rely on the work of the PAII. Meanwhile, the Framework recognises that the Protocol's portfolio-level target-setting methodology can be used to assist investors in the setting of their near-term emissions reduction targets.

Accounting for carbon emissions or climate risk in portfolios does not necessarily contribute to changes in the real economy. In this regard, both frameworks are concerned with aligning investment portfolios towards net-zero in a manner that contributes to reducing global greenhouse gas emissions.

"Impact," defined as the reduction of emissions in the real economy, was the first of five principles that guided the work of the PAII[5] and the Framework is intended to "encourage investors to maximise their efforts to achieve the greatest impact possible", defined as emissions reductions in the real economy. Likewise, the formal commitment required to join the Alliance underlines that members' commitments to transitioning their investment portfolio to net-zero "must emphasise greenhouse gas emissions reduction outcomes in the real economy".

As such, these frameworks go beyond simply requiring the integration of climate change risks and opportunities into investor activities and demand evidence of investor activity consistent with the promotion of positive climate change impact. The frameworks are meant to encourage and assist each investor to go as far as possible in the implementation of investment strategies and investor actions that promote positive climate impact while meeting fiduciary duties and regulatory constraints.

Impact Mechanisms

Driving down emissions in the real economy through investments is of course a much more ambitious objective than simply holding assets that are associated with firms that have a positive impact on the mitigation of overall GHG emissions. Alignment with values can be achieved quite easily as long as we are able to measure firms' performance on a given dimension of social or environmental values as well as an investor's preferences on such values. For example, with reliable information on GHG emissions, we can align a portfolio with an investor's preference to not hold stocks of high-emitting companies. It is much more difficult to establish whether a given investment strategy will cause companies to emit less GHG overall. Understanding how investors can achieve impact requires careful analysis of the channels through which investors can influence firm's decisions to emit more or less GHG.

An initial and important dimension of this potential investor impact on real-economy emissions is that it is necessarily indirect and implemented through different transmission channels. Among these channels, we can clearly differentiate between engagement and capital allocation.

5 - The other principles defined in IIGCC (2021) are: Rigour (basing alignment on sound evidence and data in a manner consistent with the best available science); Practicality (being feasible for a range of investors, building on existing work, and being compatible with existing processes or requirements of investors); Accessibility (definitions, methodologies and strategies should be clear and easily applied, using publicly available information and assessments where possible); and Accountability (definitions, methodologies and strategies should stakeholders to assess alignment).

1. Introduction

Table 1 provides an overview of these two channels. First, investors provide capital to firms, which allows firms to develop their activities at scale. Green investors may provide additional capital or require lower compensation for providing capital to greener firms. This would have an effect of allowing greener firms to upscale but it would also incite less green firms to become greener to lower their cost of capital. The second channel is engagement. Any investor can hold dialogue with management to express a concern for firms to become more climate friendly. For example, a firm might have incentives to go greener if investors who do not currently hold its shares express that they might start buying shares of the company if it embraces greener practices. Another form of engagement is that shareholders can make proposals and vote and thus may force companies to become greener.

Table 1: Channels for Investor Impact

Channel	Impact
Capital Supply	Upscale/downscale the activity of climate leaders/laggards
	Incentivise companies to become greener
Engagement	Dialogue with management (any investor)
	Shareholder voting and proposals

Note that the illustration does not consider impact via advocacy to influence political decisions, which is an additional possibility.

Table 1 shows engagement and capital allocation as two distinct channels of investor impact on corporate GHG emissions. It is important to note, however, that these two channels are tightly linked. In particular, if engagement consists of mere dialogue with companies without any consequence in terms of portfolio decisions, investors are unlikely to set relevant incentives for corporate managers to act based on such dialogue. Dawkins (2018) emphasises that "engagement as a negotiating posture is hollow without the explicit threat of withdrawal". Similarly, institutional investor initiatives on climate change recommend that investors link portfolio decisions and engagement strategy. For example, the Paris-Aligned Investment Initiative states in its implementation guide that an engagement strategy should have "clear milestones and an escalation process with a feedback loop to investment, weighting, and divestment decisions".

Historically, the implementation of investors' change agenda was carried out on the basis of a fairly limited view of the subjects of capital allocation and engagement. It essentially involved excluding companies with significant involvement in the supply chain, or even the consumption, of fossil fuels associated with unacceptable environmental consequences, such as coal or 'dirty' oil for example. Some of these exclusions followed, or were concurrent or at least consistent with, engagement with these same companies to reduce their involvement in controversial fuels, even though exclusion and engagement may have been performed by different investors. For investors favouring engagement, exclusion was often presented as a tool to be used when engagement is futile or has failed to produce the desired changes.

With the arrival of net-zero investment strategies, which promote alignment of all sectors and companies, while it appeared consistent to extend engagement practices to issuers with a material impact on climate change, it seemed difficult to continue to think solely in terms of exclusions to implement capital allocation that would be consistent with this objective of global alignment of the economy.

1. Introduction

It is in this context that climate portfolio decisions could no longer correspond solely to very limited exclusions established on the basis of unacceptable activities or practices from a climate perspective but should also encompass very broad changes in portfolio allocations. These reallocations should favour climate leaders, whether involving extremely carbon efficient companies or companies that have committed to being so at a horizon and with a trajectory compatible with the climate-alignment scenarios selected by the investor, or companies providing solutions to improve the carbon efficiency and alignment of other companies and economic agents. Conversely, climate laggards should be penalised by these same reallocations. Climate benchmarks, often marketed as alignment benchmarks and even officially labelled as such in the European Union, were promoted based on this idea of capital allocation compatible with the objectives of investor commitments to climate transition.

Greenwashing Issues in Current Climate Investment Practice

We differentiate between two types of greenwashing relating to investments that have the stated objective of improving climate impact.

• The first relates to investment in companies that practice greenwashing themselves. This investment can be made with or without knowledge of the problem. In the latter case, it often involves managers turning a blind eye to the greenwashing practices of companies that they do not want to exclude or underweight for financial reasons. This greenwashing of corporations, where firms try to make the public believe that they are doing more to protect the environment than they actually are, has been widely criticised. It can however have subtle forms, with the company putting in place medium- and long-term climate alignment commitments without these commitments giving rise to actions whose impact is consistent with the objectives and that can be checked as such.

• In addition to corporate greenwashing, there is now portfolio greenwashing. Investment managers may try to make investors believe that their funds help to protect the environment when they actually do not.

Climate benchmarks, or active funds that refer to a net-zero objective, display fine weighted average carbon intensity metrics and fine commitments to respecting carbon intensity compressions over time, and in the same spirit, fine portfolio temperatures that relate carbon emissions and emissions targets to climate outcomes. However, these metrics refer to a global portfolio and not to stock-by-stock allocation decisions. What is at stake with alignment is actually situated at the level of each company that is a potential portfolio constituent. A more detailed assessment of the composition of so-called 'aligned' portfolios and benchmarks is necessary to determine if there is consistency between the metrics displayed at the portfolio level and the investment decisions at the stock level. This detailed assessment is the subject of a dedicated section in the current report.

This inconsistency could in fact arise from an endemic phenomenon. The financial industry has always adopted di Lampedusa's motto of changing everything so that everything remains the same. The latter has always resulted very tangibly in the setting of extremely narrow tracking error objectives,

1. Introduction

and climate strategies do not escape this rule. Scientists are drawing attention to the need for a new industrial revolution to avert a climate catastrophe, which like previous industrial revolutions, would require considerable reallocation of capital. Yet the financial industry is acting as if cap-weighted (CW) indices that reflect our current carbon-intensive economies remain the right reference for investment with minute deviations being quite enough to solve the planet's problems. An important question for investors is whether such anchoring in cap-weighted indices still enables portfolio weights to be different enough to generate any impact at the company level, or whether what is labelled as climate investing boils down to business-as-usual investing merely wrapped in a different cloth.

Indeed, there is nothing to guarantee that these fine portfolio metrics will result in investment decisions that are consistent at the stock level, and therefore incentivise the required changes in the real economy. On the contrary, by favouring cap-weighted anchored tilting or optimisation approaches to control tracking error, strategies which promote net-zero or alignment investing are incapable of guaranteeing any consistency between the climate performance of the stocks that make up the portfolio or the benchmark and the evolution of their weights. Where is the value in investors' engaging issuers to improve their climate performance if at the same time these investors, through their portfolio decisions, favour companies whose climate performance deteriorates over time?

This lack of consistency between the evolution of companies' climate performance and their weights in green portfolios has very negative consequences for the impact of investor engagement on these same companies, and especially on their positive response to the request for a climate alignment plan. Indeed, in such a context of inconsistency between engagement and investors' portfolio decisions, the issuers will not hesitate to provide them with climate alignment answers that will not necessarily be followed by effects. Moreover, we often observe that many alignment plans proposed by corporates to respond to investor requests lack precision in terms of investment and the real climate consequences of the choices of technology or production method and of the implementation of reporting on progress made. Ultimately, net-zero alignment is often evaluated in terms of discourse about change and formal governance rather than the capacity for real change. This approach organises ambitious objectives with deadlines that are beyond the anticipated term of the mandate of the directors of the companies engaged. The obvious risk is that medium- or long-term climate promises will not have any real short-term consequences.

This greenwashing at stock level is even more pronounced when, in order to promote ambitious approaches, providers of climate solutions are prepared to use data that look attractive but ultimately turn out to lack robustness, to the detriment of metrics that are certainly more modest but have the merit of being verified or at least verifiable. This is particularly the case for Scope 3 emissions data, which represents emissions in the value chains of companies beyond their direct emissions and the indirect emissions linked to their purchases of electricity (Scope 1 and 2 emissions, respectively). The consideration of Scope 3 emissions is material as, on average, they represent more than three-quarters of company emissions. This importance, and the concern for improving footprint comparisons by recognising that corporate differences in outsourcing or production method choices affecting the

1. Introduction

Scope 1 and 2 emissions, are arguments for the integration of Scope 3 emissions into the analysis. But Total Emissions data including Scope 3 still need to be reliable. While the Scope 1 and 2 data is often subject to reporting obligations and is ultimately fairly convergent even when modelled by providers, this is not the case for Scope 3 data, where the correlation between the data produced by the providers is low (circa 15% on average according to Busch et al., 2020). Indeed, this data is produced by estimation models that either lack transparency or use data in jurisdictions where reporting obligations are limited. Claiming that the Scope 1 and 2 data from their Asian sub-contractors is taken into consideration in the Scope 3 data of European or US companies is more a question of credulity than of measurement. Ultimately, to display fine portfolio-level Total Emissions metrics, index providers and asset managers will naturally be tempted to integrate unreliable Scope 3 emissions data into their asset selection and weighting processes that through their weight will override/dilute fairly reliable Scope 1 and 2 information (Ducoulombier, 2021). Here too, the old adage of garbage in/garbage out applies, and one might think that climate strategies are unfortunately consenting victims because the errors in determining the weights of the stocks relating to these data that are not particularly robust will often be magnified by optimisation processes. In this empirical study, we will not analyse the question of reliability of different types of emission data further.

It is this concern for the robustness of the weighting methodology that should lead investors to use Scope 3 data prudently and with great care. Of course, the pressure on Scope 3 reporting is increasing and data providers are investing in its estimation, so it is possible that it could be used more intensely in the future, but serious evaluations and robustness precautions should be preferred to announcement effects. We leave an investigation of this issue for further research and as such we have not integrated an analysis of this subject into the present report.

While the subject of greenwashing is very present in portfolio decisions at stock level, it is also very present in the sector deviations observed in sector benchmarks. There is extensive discussion on the usefulness of divesting from the fossil-fuel sector as of now, or on the contrary favouring its decarbonisation, in particular with the question of its participation in the potential energy revolution linked to the use of hydrogen. There is also a consensus for calling the use of coal as a fossil energy into question. However, for all other sectors of the economy, the strong sector deviations observed in strategies that are termed 'alignment' demand attention. The work on best practice in climate alignment recommends favouring intra-sector decarbonisation, and that the macro-consistency of the real economy represented by the weights of the sectors in CW benchmarks be preserved when consistent with overall economic alignment. However, due to their construction rules, climate strategies and benchmarks may exhibit strong sector deviations by organising their decarbonisation through a reduction in the capital allocation to sectors with strong climate intensity. An under-representation of sectors that are key not only for growth but also for energy transition would be particularly problematic. Since considerable investment is necessary to ensure electrification of the economy and decarbonisation of electricity, underfunding of this sector in climate-aligned benchmarks or strategies would constitute a form of greenwashing.

1. Introduction

Separating Impact from Warm Glow Effects: "Doing Good" or Merely "Feeling Good"?

The standard answer to externalities from GHG emissions, well established by environmental economists[6], is to resort to Pigouvian taxes. Such taxes will increase the price of carbon, be it through a direct tax or a cap-and-trade mechanism. Economic models show that such a carbon price would be the first-best solution that maximises social welfare. The key question for policy makers is to set the right price for carbon, also known as the social cost of carbon. While such a solution would be highly effective, there is scepticism that the necessary arrangements will indeed be implemented by policy makers. This is due to lack of international cooperation, political short termism, influence of lobbies etc. The question then arises whether there is a second-best solution through private capital. This is where climate investing can play a role. An important question is how far this second-best solution will be from the first-best (e.g. Hong, Wang and Yang, 2021). Given the failure of governments to address climate change, generating impact is a key motivation for investors in climate investing strategies. Even if climate investing can only be second-best to government intervention, investors still need to make sure that they attain the highest impact they can.

Providers of climate strategies often emphasise portfolio scores (e.g., average carbon intensity, implied temperature rise). However, an attractive weighted average climate score of firms held in a portfolio does not imply that the investor is having an impact on the behaviour of firms and the level of emissions in the real economy. The extensive use of portfolio scores to suggest that sustainable investment strategies have a virtue in the real economy has been heavily criticised. Stanford economist John Cochrane argued that claims of virtue by asset managers may have little substance and this issue could be addressed by holding them legally accountable for the validity of such claims: "*being forced to document their virtue, with criminal penalties for securities fraud hanging in the balance, would show just how empty this whole exercise is*" (Cochrane, 2021).

Indeed, simply investing in "virtuous" companies does not necessarily achieve any real impact. Economists make an important distinction between impact and mere warm-glow effects when economic agents are motivated by non-pecuniary aspects (Andreoni, 1989). Warm-glow effects of environmentally-friendly or socially responsible investments refer to the effect of "feeling good" about one's investments. Such effects increase an investor's own utility by lowering disutility from being associated with firms which inflict significant damage upon the environment. Not being associated with such firms corresponds to a non-consequentialist motivation, that is, not being associated with the high-polluting firm does not imply that this firm generate less harm to the environment. Impact investors, on the other hand, have a consequentialist motivation. With their investment, they want to contribute to the firm polluting less. This could be achieved either because the firm reduces its scale of production, or because it improves its practices and adopts cleaner technology to produce its outputs.

Assessing whether investments have impact requires a *counterfactual*. If an investment claims to have impact, we can test this claim by measuring what the amount of emissions would have been if the investment had not been made. Thinking about the counterfactual often suggests that commonly-

6 - See, e.g., Nordhaus (2019)

1. Introduction

used climate and ESG strategies do not generate impact, at least not in a straightforward way. If a pension fund underweights companies with a large carbon emission score, this underweighting per se does not change the carbon emissions of the respective company or that of other companies. Instead, impact will only occur through one of the two channels outlined above. The green investor could have a direct impact on the firm's cost of capital. An increased cost of capital could lead to a reduction in emissions through reduced investments as the firm finds it harder to identify projects with positive net present value. Or the investor's portfolio decision could send a signal to the company that it should adopt cleaner technology, which in turn would reduce emissions. If the company's management reacts to this signal in the desired way, the investor will achieve impact. The key question for climate strategies is therefore whether they effectively employ the capital supply channel and the signalling channel to drive firms to reduce emissions.

How to best achieve impact by drawing on green investments is subject to debate. On the one hand, there are both theoretical and empirical results that suggest that divesting from carbon-intense assets allows a positive impact to be generated in the real economy. On the other hand, the literature voices substantial scepticism that current ESG investment practices are able to deliver impact.

The positive impact of divestments on the environment have been analysed theoretically by Heinkel, Krause and Zechner (2001). They show that green investors, by shunning brown stocks, drive up the cost of capital for brown firms, thus either inducing these companies to go greener or to scale down their activity. Similar results are documented in a theoretical model of sustainable investing by Pastor, Stambaugh and Taylor (2020). Recent empirical evidence suggests that trades by mutual funds that aim to decarbonise portfolios drive down the stock prices of brown firms. Subsequent to these declines in stock prices, brown firms reduce their carbon intensity (Rohleder, Wilkens and Zink 2021).

However, there are several results suggesting that current practices in ESG investing are unlikely to achieve impact. Current practices draw on two elements to design ESG strategies. First, investment practice heavily focusses on the use of ESG scores, as produced by commercial ratings providers. These scores are created from qualitative analysis, as conducted by hundreds of ESG analysts, that are then boiled down into quantitative metrics, e.g., numerical scores ranging from 0-10. Second, practices aim to obtain a high weighted average score for portfolios that is then displayed as proof of attaining ESG objectives. Recent academic research suggests that such practices are inappropriate to maximise investors' impact on firm behaviour. Below, we discuss several findings in recent research that question the impact of current ESG and climate investing practices.

Environmental innovation is likely to play a crucial role in the transition to a greener economy and ESG investors likely would want to exploit the capital allocation channel and the signalling channel to support environmental innovation. Cohen, Gurun and Nguyen (2021) study green patenting across firms and raise the question of whether capital allocation based on ESG considerations is aligned with incentives to innovate. They find that firms that rank poorly on an environmental rating provided by Sustainalytics tend to produce more and higher quality green patents than highly-rated firms.

1. Introduction

They identify firms in the energy sector as key contributors to environmental innovation, producing more and higher quality patents for green technology and especially in the area of climate change mitigation for energy provision. Extensive robustness checks conducted by the authors further show that results are not due to "strategic patenting" by energy firms that would try to block competitors or merely suggest greenness for public relations. Instead, energy firms with poor ESG scores actively invest to develop and exploit their patented innovations. Despite their strong contribution to green innovation, energy firms are often excluded from ESG and climate strategies in current ESG investment practices, without trying to distinguish across firms within this sector. Likewise, ESG strategies typically favour highly-rated firms, which are shown to contribute less to environmental innovation.

Landier and Lovo (2021) analyse mechanisms of impact in a theoretical model. In their model, investors try to create impact while maintaining market-level returns, and firms face financing restrictions, which incites them to respect emissions constraints. They derive several interesting recommendations for sustainable investing. First, they show that an ESG fund "that just defines its strategy as a cross-sector capital allocation has no impact on social welfare". In other words, greenifying portfolios by avoiding the worst sectors does not lead to a reduction in emissions. Second, to have an impact, the ESG fund needs to signal to individual firms that it will not supply capital if constraints on firm emissions are not respected by the firm. This principle requires that an effective investment strategy needs to first evaluate emissions at the individual firm level and then make its capital allocation dependent on these emissions fulfilling acceptable standards. Importantly, the recommendation on how to invest for impact conflicts with common practices of ESG funds. The authors show that the footprint or weighted average emission at the portfolio level are not good indicators of impact, and in fact might even be "*potentially highly misleading*". The authors emphasise for example that "*investing in an industry that does not pollute is simply useless in terms of impact and consumes some of the ESG fund impact capacity in other sectors*".

Recent papers by Green and Roth (2020) and Oehemke and Opp (2020) develop economic models of ESG investing with their impact. The models underscore the importance of thinking carefully about the measure of social value-added that investors use when they pursue impact. For example, Green and Roth emphasise that analysing the greenness of portfolio companies alone and tilting the portfolio to the greenest stocks is not likely to generate impact. In particular, they argue that holding green stocks that are in strong demand by business-as-usual investors due to their high profitability does not generate impact, as socially motivated investors merely displace business-as-usual investors. Oehmke and Opp (2020) suggest that investors need to think carefully about social value added. Instead of focussing on holding the greenest firms, investors need to figure out which firms could help avoid emissions relative to a counterfactual where these firms receive insufficient financing. The authors emphasise that "*investments in sin industries are not necessarily inconsistent with the mandate of being socially responsible*". This is the case because funding firms in high polluting industries that adopt relatively cleaner technologies than their peers actually may help avoid more emissions than funding firms in industries which have very low emissions.

1. Introduction

Brest, Gilson and Wolfson (2019) discuss the challenges ESG investing faces in order to have real impact. They recognise that ESG investments can affect company behaviour through two potential channels, a financing channel (directly affecting cost of capital) and a signalling channel (which may also indirectly affect cost of capital). However, they emphasise that providers' claims about impact are not rigorously backed up: "*Precisely because the socially-motivated market sector is growing so rapidly, participants on both the sell-side and the buy-side of the market label their activities in a loose fashion that reflects either their aspirations or their marketing strategies rather than measurable results.*"

Diagnosing Greenwashing

Building on the discussion in the two preceding sub-sections, we propose three types of indicators of consistency in portfolio strategies with impact on company's GHG emissions or climate performance. In fact, both our critical analysis of greenwashing risk in current investment practice and our brief review of the literature on how to construct portfolios in the presence of impact objectives provide some guidance for reasonable indicators of greenwashing risks. It is worth noting that none of our indicators consider aggregate portfolio scores of greenness. This is consistent with our discussion above that such indicators may hide important stock-level features or effects related to industry exposures. Of course, this does not mean that investors should look away from aggregate portfolio scores. Aggregate portfolio scores, such as weighted average carbon intensity, provide useful information on values alignment for investors who want to be associated with greener companies, as well as useful information on transition risk, if carbon intensity is accepted as a proxy for such risk. However, we propose to look at investment characteristics in more detail to assess consistency with the objectives of consequentialist investors, who seek impact on corporate emissions. The indicators we propose are simple to calculate, and only require data on the climate scores targeted by a given strategy, sector classification of stocks, as well as strategy weights. They could thus be deployed widely and easily to assess impact consistency of different strategies.

Each type of indicator assesses whether conditions that are necessary for impact are fulfilled. Our indicators can be seen as assessing minimum requirements for impact from a given strategy. We focus on the following three selected issues, which are not meant to be exhaustive[7].

Detecting Closet Business-as-Usual Investing

Weights of stocks in a climate strategy should be related to climate performance of firms. If a strategy allocates weights to stocks in a way that is not really related to their climate performance, this would conflict with an objective to generate impact. Active managers are often criticised for staying very close to the weights of broad market indices, as these indices are used as a benchmark in performance evaluation. This dominance of benchmark weights means that any manager skill deployed in the strategy will not have a major influence on risk and returns. Instead, risk and returns are determined by the benchmark, with minor deviations that are due to manager skill. This practice is also described as "closet indexing" and is heavily criticised because investors bear the explicit (management fees) and implicit (selection process and performance monitoring) costs of active management while holding portfolios that are mostly determined by passive benchmarks.

7 - A separate but important issue is that popular greenness measures may be inappropriate (Ducoulombier and Liu, 2021)

1. Introduction

A similar phenomenon could occur with climate strategies. Climate strategies employ not only emissions data, but also more qualitative data on disclosure quality, carbon risks, company commitments etc., that are often collected by large teams of analysts. If this information is only used to generate marginal deviations from market-capitalisation-weighted indices, climate strategies would mostly resemble business-as-usual investing. In fact, market cap-weighted indices reflect the portfolio of the average investor on publicly-listed equity markets. Investors with a particular concern for climate issues would need to hold portfolios that are considerably different. To determine whether this is the case, we assess whether climate strategies correspond to "closet business-as-usual investing" that does not differ to a large extent from cap-weighted benchmarks, despite displaying higher score of greenness. In particular, we assess what the key determinants of portfolio weights are, and how climate scores impact portfolio weights in relation to other characteristics, such as market capitalisation or general ESG scores.

Detecting Industry Compression

It is easy to display greenness by down-weighting high emissions sectors. In fact, it is well-known that carbon emissions are highly concentrated in few stocks and in few sectors, such as the energy sector or the electricity sector[8]. If investors want to employ the capital allocation channel to restrict investment capacity of firms in such sectors, they also need to be aware that the outputs of these sectors, notably energy and electricity, are essential goods for the functioning of the economy. The key issue is not how to restrict investment in these industries, but rather, how to make sure that these industries invest in technology that allows them to produce these goods without emitting greenhouse gases. We discussed above that there is evidence of high innovative capacity for green technology in such industries. We also discussed economic models which suggest that impact cannot be achieved simply by down-weighting the most emission intensive sectors in the economy. Drawing on these insights, we assess whether climate strategies simply underweight such key economic sectors, which would be inconsistent with impact objectives. This is also in line with institutional investor initiatives which recognise that firms in key economic sectors require funding and incentives to go green (IIGCC, 2021). To assess whether climate strategies merely underweight sectors, we will look at changes in sector allocation over market indices, the contribution of sector weighting decisions to reductions in portfolio climate scores, as well as the weighting decisions of key economic sectors, like electricity.

Detecting Blurred Signals

A portfolio's green score, computed as the weighted average score of its constituents, does not account for individual firm dynamics. For example, an investor who starts with a cap-weighted index, could overweight a firm that has dramatically worsening carbon emissions as long as it remains better than the market average in terms of emissions level. This decision would lead to an improvement in the portfolio's green score over the cap-weighted index. If the investor is large enough, their purchase of the firm's stock could lead to a price impact or to a signal to company management that investors are not penalising the company for its decreasing green score. Such a weighting decision is thus at odds with the idea that green investors should send clear signals to firms' management to incite them to become greener. For example, Andersson, Bolten and Samama (2016) analyse low carbon

8 - Also see Bolton and Kacperczyk (2021) on the empirical properties of carbon emissions and carbon intensity in the cross section of firms.

1. Introduction

investment strategies and argue that "clear communication" of strategy weights should show that a strategy "rewards companies for their efforts in reducing their carbon footprint" and "disciplines" companies that do not behave well. In addition, they argue that selling pressure on companies with poor behaviour "might induce these companies to take action to reduce their carbon footprint and to reward their CEOs for any carbon footprint reductions". If such a mechanism is valid, then increasing the weight of companies with deteriorating carbon intensity, as in the example above, would be counterproductive.

"Clear communication" and consistency of portfolio weights with corporate environmental behaviour is also important for engagement strategies to be effective. In fact, many investors rely on dialogue with companies to emphasise the urge of improving greenness. However, engagement is a toothless tiger if there is no threat of divestment (see Dawkins 2018, IIGCC 2021). Investors who engage with companies should ensure that stock weights evolve in line with their engagement messages to create synergies between portfolio construction and engagement. For example, if an investor pressures a company to reduce its carbon intensity, it would be counterproductive for effective engagement if the then investor raises its portfolio weight at the same time as telling management that they are on the wrong track concerning carbon emissions.

To detect how portfolio decisions in climate strategies suffer from blurred signals , we will analyse stocks with deteriorating climate scores, and report to what extent climate strategies increase the weight in such deteriorators. We will also analyse whether changes in climate score influence changes in a stock's weight in climate strategies.

What we Find: Popular Weighting Methods in Climate Strategies are not Aligned with Impact Objectives

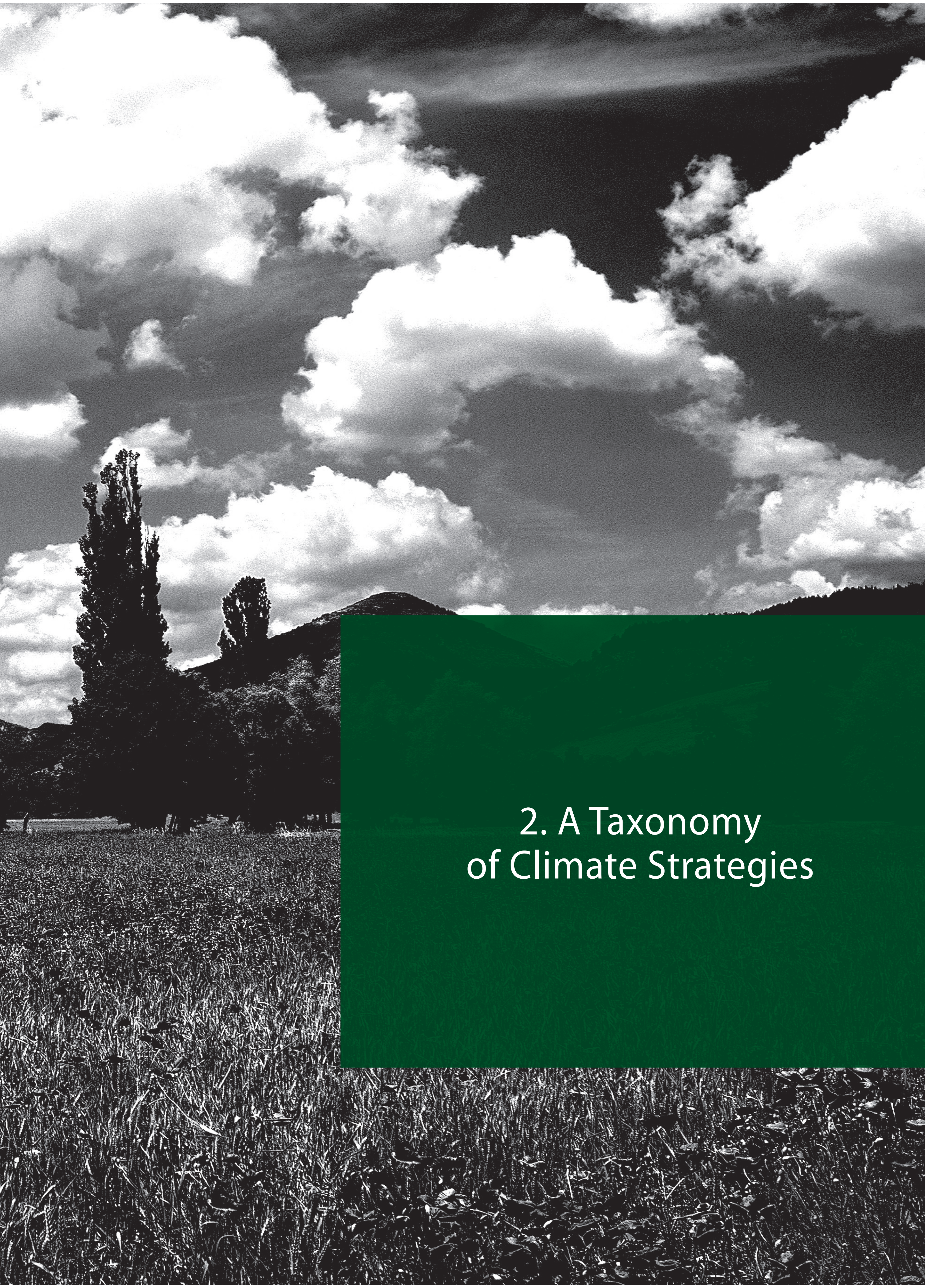
In this paper, we build stylised climate strategies in a global equity universe to assess whether such strategies fulfil the three impact criteria mentioned above. Across 32 specifications of stylised strategies that build on commonly-used weighting schemes and GHG emissions data, we find that climate strategies are inconsistent with influencing firms to reduce their emissions.

Climate scores only have a marginal impact on weights. Weights are driven mainly by other aspects, such as market cap. Strikingly, strategies are indifferent in their allocation decisions to deteriorating climate performance of firms. A key mechanism creating the warm glow effect of improved portfolio climate scores is simple underweighting of essential sectors with high emissions.

We conduct extensive robustness checks and confirm that introducing additional elements of investment practice does not alter the diagnosis of these problems. Incorporating emission trajectories and constraints on high climate impact sectors, as required by the EU regulation for Paris-Aligned Benchmarks, does not address any of the problems we document. Using commercial ratings for environmental or climate scores, we find that the main problems emphasised in stylised strategies prevail, though at a more moderate level.

1. Introduction

The remainder of the paper is organised as follows. Section two proposes a taxonomy of climate investing strategies, based on popular weighting schemes used to construct portfolios. Section three identifies the determinants of stock weights in climate strategies and the relative importance of non-climate aspects over climate scores. Section four assesses how strategies' allocation decisions treat stocks with deteriorating climate performance. Section five assesses whether weights in essential sectors with high climate intensity are consistent with funding of key sectors. A final section concludes.



2. A Taxonomy of Climate Strategies

2. A Taxonomy of Climate Strategies

We explained in the introduction how greenwashing risks are pervasive in climate investing. Indeed to achieve a material impact in mitigating the consequences of climate change, investors would need to go beyond simply improving portfolio level metrics such as weighted average carbon intensity; inducing changes in corporate behaviour should be the ultimate goal of environmentally conscious investors. Climate investment products are a natural channel for such efforts, but how can we perform due diligence on the large variety of products leveraging numerous variations of security screenings, carbon performance measures, weighting schemes and input data? We need to focus on certain key methodological features that are the most meaningful for impact. In order to better structure our analysis, we propose a taxonomy of climate strategies to help us derive insight based on methodological elements that are commonly found across different equity climate investment products.

Our motivations for defining a taxonomy are two-fold: firstly we want to take a neutral perspective. Classifying climate strategies along dividing lines that are solely based on methodological approaches ensures that our analysis is not aimed at providing commentary on specific products or providers, with the idiosyncrasies that would inevitably exist. Secondly, the taxonomy helps to highlight the important mechanisms that we are concerned with and maintain the focus on the key issues. On the latter point, like any taxonomy, the one proposed in this research allows the multiple climate investing approaches and offerings to be reduced to stylised facts that are representative of key features. It enables conclusions to be drawn that are not only relevant but also robust in order to respond to a question that concerns the investment industry as a whole rather than a particular asset manager or index provider. As such, it will be important to consider that the providers or managers cited in the study are cited for illustrative purposes and not because they are more subject to greenwashing risks than others. The objective criteria that led to them being chosen are based on the popularity of the funds or benchmarks proposed.

We discussed in the previous section that beside engagement endeavours, investment decisions are how investors can express their views and influence corporate strategies. In that sense, portfolio weights are the practical reflection of investors' preferences, which in aggregate are one of the drivers that dictate the supply of capital. It is then crucial that, in a climate strategy, the portfolio weights remain consistent with the overall message investors wish to convey to companies. Thus it appears natural to look into what weighting schemes are being used in climate strategies and how they shape the signals sent to corporations.

Portfolio weights have attractive properties to serve as the basis for our analysis: they are observable with no assumptions on investor preferences, hence any investment strategy can be evaluated through this lens with minimal subjectivity. Portfolios weights can also be accessed readily by investors, stakeholders and investee firms themselves.

In our analysis of climate strategies, we focus on index-based products that replicate indices with publicly-disclosed index rules, simply because our analysis requires precise description of the weighting mechanisms in play, which rules-based index methodology documents provide. We have no way of assessing active climate investment products that use discretionary investment processes.

2. A Taxonomy of Climate Strategies

Looking at the climate index offerings in the marketplace, although products come in various flavours when it comes to carbon measures, security screenings, or input data, we can clearly distinguish two main approaches to stock weighting: a tilting approach and an optimisation based approach.

The tilting approach consists of taking the market capitalisation weight of a stock and multiplying it by an adjustment factor. In the case of climate strategies, the adjustment factor would be based on one or more climate scores representing climate performance, which results in post-normalisation portfolio weights that are tilted toward climate-friendly companies and tilted away from brown companies. That is a typical way of constructing portfolios, with the potential to incorporate multiples objectives simultaneously with multiplicative adjustment factors representing each objective.

The second approach is optimisation-based, usually targeting a minimum level of improvement in climate metrics while portfolio weights are optimised to minimise deviation from a market-cap-weighted reference universe. The deviation from the reference universe can be measured as the sum of stock level active weights or the ex-ante tracking error of the portfolio. This approach would typically achieve portfolio-level metric improvement at low 'cost' in a market-capitalisation-anchored framework, with evident appeal for investors with tracking error budgets.

To facilitate subsequent reference to these two main types of strategies we will use "type T" as a shorthand for tilting strategies and "type O" for optimised strategies.

The other dimension of interest is the distinction between strategies that focus on climate and strategies that combine climate objectives with general ESG objectives. If investors wish to prioritise climate change mitigation, integrating general ESG considerations could potentially lead to mixed signals when climate performance and general ESG performance diverge. We will refer to the climate-focused tilting strategies as T1 and mixed objective tilting strategies as T2, and respectively O1 and O2 for optimised strategies.

In order to gain insight on how type T and O methodologies typically behave we chose to utilise stylised strategies. Stylised strategies are based on using the key methodological ingredients of industry offerings, as discussed in the taxonomy. It is worth noting that we are not trying to reproduce the financial or environmental characteristics of a given climate investment product. Instead we are focussed on showcasing the fundamental properties attached to the common methodological approaches, notably choices concerning the weighting methodology. Our results pertain to stylised strategies that implement different weighting methodologies that also underlie climate investing products available in the industry. In addition to the analysis of stylised strategies, we also conduct a detailed analysis of the methodologies used in commercial offerings to assess whether specific constraints used in such strategies could be effective in avoiding some of the issues that appear with stylised strategies.

Using stylised strategies has some key advantages: different providers rely on different climate scores from various data providers. Analysing the consistency of climate strategies would in principle require access to the exact data used for scoring, which is typically proprietary. Instead we use several

2. A Taxonomy of Climate Strategies

candidate climate scores to construct stylised strategies and we assess strategies with respect to the score used to construct them to maintain fairness in our analysis. In addition, commercial strategies may differ from one another on many other dimensions, such as the universe used, sector definitions employed, implementation rules and constraints, etc. Abstracting from such differences allows us to analyse weighting schemes based on climate scores in isolation, thus providing a clearer picture on the properties of the key weighting schemes underlying climate investing strategies. Another advantage of our analysis is that our results are both tractable and can be easily replicated by third parties. Equipped with data on carbon emissions and a standard large and mid-cap equity universe, an external researcher can check our results. This ease of replicability is an important requirement to allow for criticism and debate around research findings.

Our protocol for the construction of the stylised portfolios is as follows:
The reference universe of our analysis is the Scientific Beta Developed Universe, a broad free-float market-capitalisation-weighted universe for developed markets equities. Strategies are rebalanced annually in June.

For the climate score we used a total of eight carbon metrics, all based on carbon emissions but with four different normalisation approaches: carbon emissions only, carbon emissions normalised by revenues, carbon emissions normalised by market capitalisation and carbon emissions normalised by enterprise value including cash. The primary data source for emissions is ISS (Institutional Shareholder Services)[9]. We found this set of specifications to be representative of commonly-used carbon metrics in the industry's offering. We also look at two different scopes for carbon emissions, one with only Scope 1 and 2 emissions and the other including Scope 1,2 and 3 emissions[10]. Because of the data quality concerns that exist for Scope 3 emissions we wish to include both approaches.

We choose to work with a wide range of carbon metrics, because we do not want to impose a view on what the right carbon metric might be, in order to be as metric-agnostic as we can in our observations. Thus we are presenting results that are averages across the eight metrics, making distinctions when results demonstrate clear divergences. Following the same logic, we evaluate each strategy with respect to the carbon metric that was used in their design to not unfairly minimise the influence of the climate score by choosing a preferred carbon metric.

When the stylised portfolio includes an ESG objective we define a mixed score as the arithmetic mean of the standardised climate score and the standardised ESG score[11]. We use the general ESG ratings from the MSCI Intangible Value Assessment datasets as a proxy of firms' overall ESG performance.

In our T stylised strategies, we use a climate-focused (T1) or mixed objective adjustment factor (T2). The adjustment factors are calculated by applying the cumulative distribution function of the standard normal distribution to the climate and ESG z-scores.

In our type O stylised strategies, we minimise the ex-ante tracking error of the portfolio while matching the weighted average climate score of the type T strategy using the same climate score. The tracking

9 - Carbon emissions data and characteristics used for normalisation are sourced from Scientific Beta. Scientific Beta emissions data use the Corporate Standard's definitions for greenhouse gas emissions and draw on ISS as a primary data source. Emissions data are updated annually in June by Scientific Beta on the basis of the figures reported at the end of the previous year.
10 - The Greenhouse Gas (GHG) Protocol Corporate Standard distinguishes three scopes of emissions: Scope 1 emissions are direct emissions from sources owned or controlled by the company; Scope 2 emissions are indirect emissions from electricity, steam, heating/cooling purchased or consumed by the company; and Scope 3 emissions are other indirect emissions in the corporate value chain.
11 - The z-score of a company characteristic expresses the distance between the raw score of the company and the mean raw score for the population of companies, in standard deviation units, i.e., relative to the variation or dispersion of the raw score values.

2. A Taxonomy of Climate Strategies

error estimation is based on a covariance matrix estimated using an implicit factor model based on principal component analysis.

Table 1 summarises our nomenclature for the stylised strategies and the core mechanisms involved.

Table 1: Nomenclature for the stylised strategies and the core mechanisms involved

	Tilting *Stock weight is market cap weight times the standardised score*	Optimisation *We minimise tracking error w.r.t. CW reference index, matching the portfolio score of the tilting strategy*
Climate - score only	T1	O1
Mixed – climate and ESG score	T2	O2

Through this protocol we aim to make our conclusions as independent as possible to biases that specific methodologies could encapsulate: do green strategies work best with ESG on top? Should we normalise carbon measures by market capitalisation, enterprise value or revenues? Should we use tilting or optimisation to weights constituents? We choose to remain neutral and use average results to drive our analysis.

Let us start with a few sanity checks on the relevance of the stylised strategies. We have seen previously how the climate strategies typically achieve high levels of reduction in carbon metrics relative to their cap-weighted reference universe. It is one of the headline features of climate strategies that is marketed heavily by providers. In this respect the stylised strategies are no exception. We can see in Table 2 that the strategies achieve reductions in carbon metrics in excess of 80% on average for climate-focused strategies and 60% for mixed objective strategies. The portfolios appear to have achieved significant improvement in greenness compared with their reference universe.

Table 2: Portfolio level climate score

Strategy type	Type T1	Type O1	Type T2	Type O2
Weighting scheme	Tilt	Optimised	Tilt	Optimised
ESG score integration	No ESG score		Include ESG score	
Portfolio-level reduction of weighted average carbon emissions metric	**-83.5%**	**-83.5%**	**-64.7%**	**-63.3%**

We report results for each strategy type, averaging across the 8 different climate scores we maintain. Our results thus provide a complete picture across the 8 climate metrics. We note that results align very closely across the 8 metrics so that averaging does not hide relevant information. We assess impact consistency measures once a year in June from 2011 to 2020 and report the average value. We thus provide a view on impact consistency observed on average over one decade. Each strategy is assessed on the specific carbon metric used in the score tilting or optimisation to ensure they have improved in 'greenness' at the portfolio level.

Financial performances are not a focus of our analysis, but in Table 3 we show some recent performance figures of the stylised strategies. This performance calculation allows us to check that these performances are comparable to those of commercialised strategies. Indeed, like actual commercial products, the stylised strategies show slight improvements in returns and Sharpe ratios over the cap weighted index over the past decade.

2. A Taxonomy of Climate Strategies

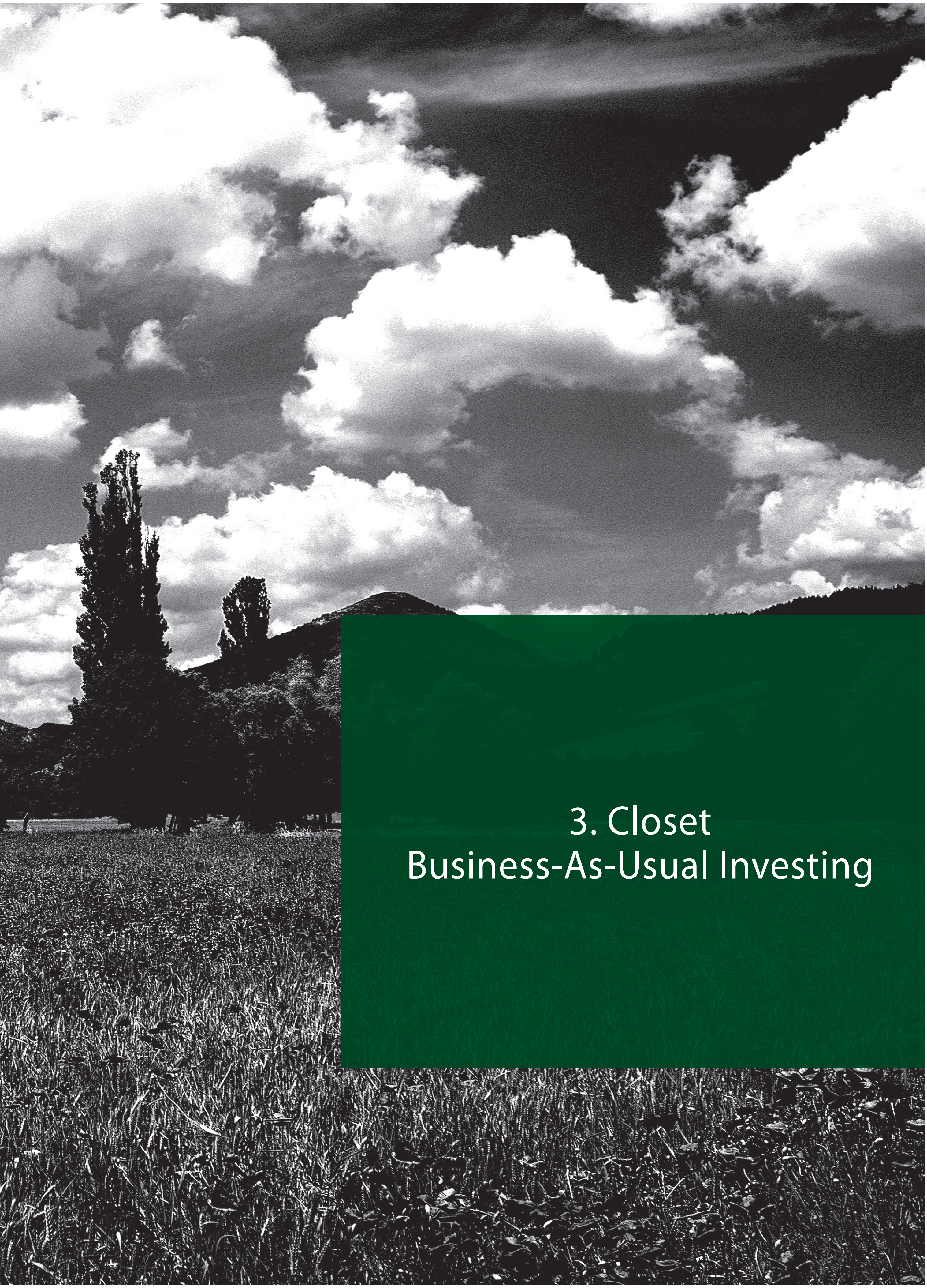
Table 3: Performance and risk metrics

Global Developed Markets Universe (30 Dec 2010 to 31 Dec 2020)	Universe	Type T1	Type O1	Type T2	Type O2
Weighting scheme	Cap weighted	Score tilt	Optimised	Score tilt	Optimised
ESG score integration	N/A	No ESG score		Include ESG score	
Average absolute performance metrics					
Ann. Absolute Return	10.29%	11.20%	10.73%	10.82%	10.73%
Ann. Volatility	14.90%	14.75%	14.64%	14.72%	14.58%
Sharpe Ratio	**0.79**	**0.85**	**0.83**	**0.83**	**0.83**
Sortino Ratio	1.07	1.16	1.13	1.13	1.13
Max Drawdown	33.77%	33.30%	33.90%	33.01%	33.46%
Average relative performance metrics					
Ann. Relative Return	N/A	**0.91%**	**0.45%**	**0.53%**	**0.45%**
Ann. Tracking Error	N/A	1.04%	0.91%	1.48%	1.00%
Information Ratio	N/A	0.87	0.48	0.36	0.44
Treynor Ratio	N/A	0.13	0.12	0.12	0.12
Max Relative Drawdown	N/A	2.12%	2.26%	2.40%	2.13%
Max Relative Loss	N/A	0.63%	0.60%	1.07%	0.75%

Performance computed from daily USD total return index values

Overall, our stylised strategies align well[12] with commercial strategies in the sense that they reduce overall carbon intensities in a dramatic way and show attractive returns over the past decade. Analysing these two points is however not the objective of our analysis. Instead, we focus on analysing whether, irrespective of these appealing features, strategies show consistency with investors' impact objectives. In the subsequent sections we will present our main results to provide an overview of where, in our opinion, the most important issues of impact inconsistency lie.

12 - We detail calendar performances of the stylised strategies along with a selection of commercial products with publicly available returns in Appendix 3 to illustrate comparability.



3. Closet Business-As-Usual Investing

3. Closet Business-As-Usual Investing

Our first concern is to identify the drivers of portfolio weights in climate strategies. Indeed, a basic requirement for impact is that climate considerations are dominating other factors that are unrelated to climate issues. In contrast, it is hard to conceive that strategies that are mainly driven by issues other than climate performance could possibly have a positive climate impact, in particular a granular impact on corporate incentives to commit to and implement ambitious transition plans. Mixed results in this area would challenge the narratives of sustainable investing shaping up to be a major actor in the fight against climate change.

To be able to demonstrate that they walk the talk, so to speak, climate investment strategies should be able to show that their weights are strongly related to measures of greenness. If the demand for capital that emanates from green investing is mostly driven by a firm's characteristics other than greenness, firms are unlikely to be pushed or pulled to go green. Both signals to firm management and a potential cost of capital wedge in favour of green firms would fizzle out if the actual capital allocation implied by green strategies was mainly driven by non-climate aspects.

To analyse the drivers of weights in climate strategies we conduct an analysis we call Weight Determinant Analysis or WDA. We conduct WDA through two approaches: a regression approach and a sorting approach.

In the regression approach WDA is similar in spirit to return based style analysis (Sharpe, 1992) but instead of focusing on returns we focus on weights. We run a simple cross-sectional regression with portfolio weights on the left hand side and characteristics on the right hand side.

$$\omega_i = a + \sum_{j=1}^{K} d_j \gamma_{i,j} + \varepsilon_i$$

d_j is the estimated impact of a one standard deviation shift in characteristics (going from an average stock to a champion stock) on the stock's weight, in basis points. $\gamma_{i,j}$ is standardised in the cross section to enable comparison between characteristics.

We look at determinant coefficients d_j to measure the strength of different drivers of weights in green strategies.

We are evaluating the strength of potential linear relationships between stock weights and firm characteristics we deem important for climate strategies. We know by construction which are the most important factors: market capitalisation, the climate score and the ESG score. We conduct a straightforward regression of portfolio weights expressed in basis points against z-scores of the three characteristics.

We report regression coefficients with statistically significant coefficients at 5% significance level in bold. Each strategy type is represented by the average values across the eight climate score definitions defined in the Introduction. For each climate score definition, we use the average coefficients and p-values[13] for statistical significance over 10 years with annual computation.

13 - The p-value measures the probability of observing the conditional on the null hypothesis being true. In other words, it measures the consistency between the data and the hypothesis being tested.

3. Closet Business-As-Usual Investing

Table 4: WDA regression of portfolio weights against key characteristics

Strategy type	Type T1	Type O1	Type T2	Type O2
Weighting scheme	Tilt	Optimised	Tilt	Optimised
ESG score integration	No ESG score		Include ESG score	
Impact on weights in basis points				
Intercept (~average weight)	**6.4**	**6.4**	**6.4**	**6.5**
Impact of market cap (1 Std Dev increase)	**13.1**	**11.9**	**13.4**	**12.1**
Impact of climate score (1 Std Dev increase)	**1.7**	**1.7**	**1.2**	**1.0**
Impact of ESG score (1 Std Dev increase)	0.1	0.0	**3.6**	**3.6**

We report results for each strategy type, averaging across the 8 different climate scores we maintain. Our results thus provide a complete picture across the 8 climate metrics. We note that results align very closely across the 8 metrics so that averaging does not hide relevant information. We assess impact consistency measures once a year in June from 2011 to 2020 and report the average value. We thus provide a view on impact consistency observed on average over one decade. Each strategy is assessed on the specific carbon metric used in the score tilting or optimisation to ensure they have improved in 'greenness' at the portfolio level.

The regression has high explanatory power with an average R-squared of 0.86 (not reported in the table for brevity): the chosen characteristics are indeed driving the portfolio weights. We note the intercept is close to the average weight in an equally-weighted portfolio over the period.

Looking at the more important firm characteristics, the results for tilt strategies are clear-cut: a one standard deviation increase in market capitalisation results in a 13.1 basis points increase in stock weight above the average weight for climate-focused tilt strategies. Surprisingly, a one standard deviation increase in climate score yields only a 1.7 basis points increase over the average weight in climate-focused tilt strategies. This finding is striking. The impact of climate scores is about an order of magnitude smaller than the impact of market capitalisation. Such a weak impact of the climate score questions whether climate strategies indeed reflect climate objectives in a meaningful way. When analysing tilt strategies that mix a climate score with an ESG score, we notice that the impact of the ESG score is substantially higher than the climate score. For these mixed tilt strategies, market capitalisation is the main driver of weights, with an impact of 13.4 basis points. The ESG score still has a moderate impact of 3.6 basis points. The climate score only counts for 1.2 basis points. In other words, such strategies are market-capitalisation strategies, with a moderate amount of ESG tilting and a tiny bit of climate-related tilting. Such a tiny impact clearly does not align with talk of a "sea change" or a "tectonic shift" in investing that providers of climate offerings have announced. Optimised strategies have almost identical results to tilt strategies, with a very low impact of climate scores on portfolio weights.

To facilitate comparison we also express the impact of each characteristic as a percentage of the sum of coefficients of the three main characteristics.

3. Closet Business-As-Usual Investing

Table 5: WDA regression of portfolio weights expressed as percentage of total impact

Strategy type	Type T1	Type O1	Type T2	Type O2
Weighting scheme	Tilt	Optimised	Tilt	Optimised
ESG score integration	No ESG score		Include ESG score	
	Impact of characteristic in percentage of total impact			
Impact of market cap	**88%**	**88%**	**74%**	**72%**
Impact of climate score	**12%**	**12%**	**6%**	**6%**
Impact of ESG score	**0%**	**0%**	**20%**	**22%**

We report results for each strategy type, averaging across the 8 different climate scores we maintain. Our results thus provide a complete picture across the 8 climate metrics. We note that results align very closely across the 8 metrics so that averaging does not hide relevant information. We assess impact consistency measures once a year in June from 2011 to 2020 and report the average value. We thus provide a view on impact consistency observed on average over one decade. Each strategy is assessed on the specific carbon metric used in the score tilting or optimisation to ensure they have improved in 'greenness' at the portfolio level.

This analysis shows that market capitalisation is the key driver of weights, accounting for up to 88%. The climate score still makes up between 6% to 12% in determining portfolio weights.

The second way of analysing weighting determinants is a sorting approach. Within each strategy we build weight-sorted quintile portfolios. Then we compare the spread of the three firm characteristics' z-scores between the top quintile of weights and the bottom quintile of weights.

The sorting approach is a complementary addition to the regression-based weighting-determinant analysis (WDA). Unlike the regression-based analysis, we are not making a linearity assumption here. In addition, the interpretation of results is straightforward: a large characteristic spread indicates that the respective characteristic is an important driver of weights.

Table 6: WDA Sorting: spread in characteristics between top quintile and bottom quintile portfolios

Stylised portfolio type	Type T1	Type O1	Type T2	Type O2
Weighting scheme	Score tilt	Optimised	Score tilt	Optimised
ESG score integration	No ESG score		Include ESG score	
Index weight quintile portfolios spreads (difference in weighted average z-score of top quintile - bottom quintile)				
Market cap spread	3.41	3.20	3.34	2.92
Climate score spread	0.19	0.25	0.28	0.38
ESG score spread	0.20	0.11	1.42	1.28

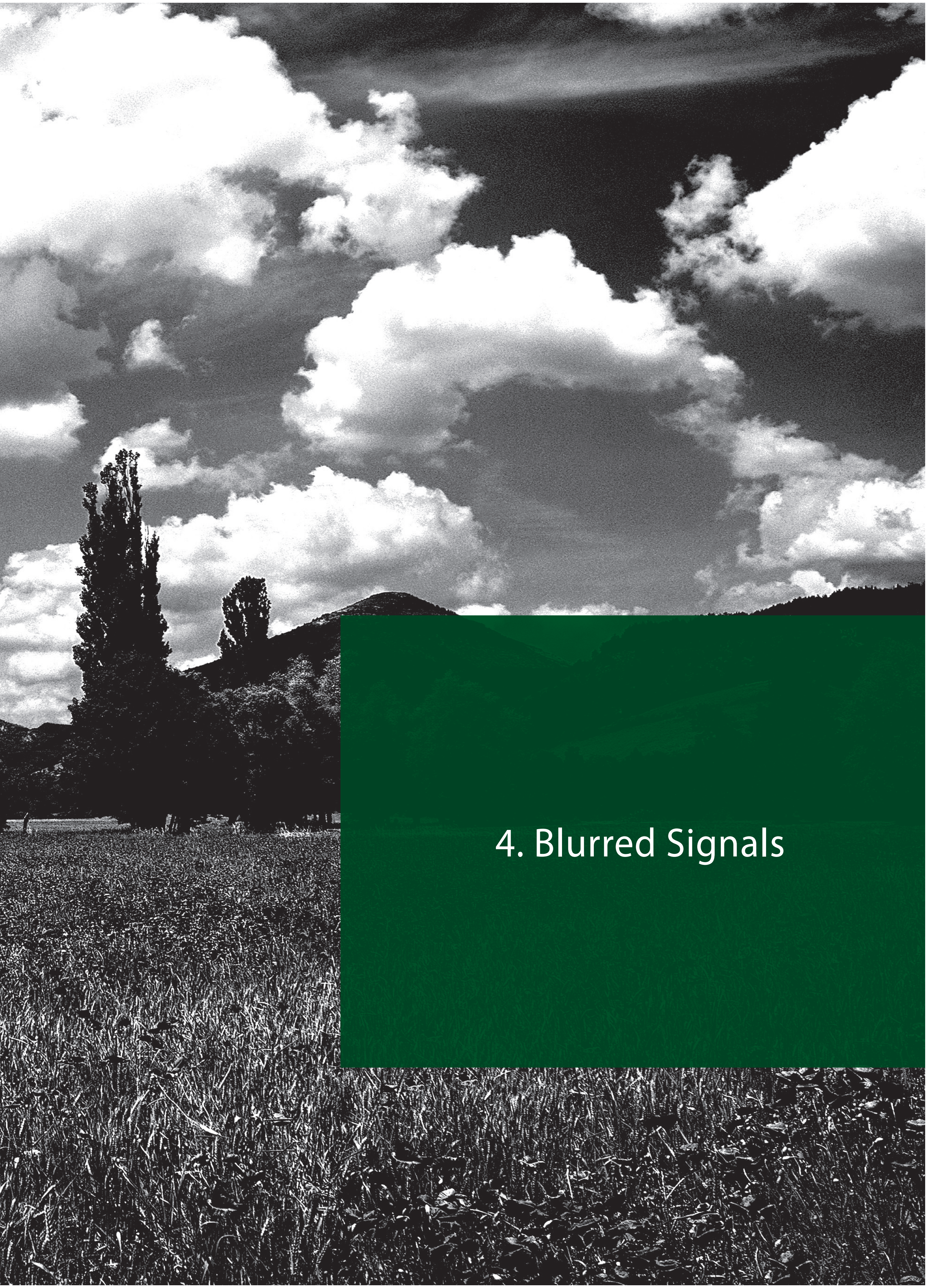
The results from the sorting-based WDA are consistent with the regression-based results: market capitalisation eclipses the climate score in importance by around one order of magnitude. When utilised, the ESG score is also more important than the climate score in determining portfolio weights.

It is hard to argue that climate strategies are diverging significantly from market-cap-weighted portfolios that represent traditional investment. By adopting a green product, the expected outcome is a portfolio that is basically still a market-cap-weighted portfolio with very little impact from the climate score. This result is consistent across specifications and weighting schemes, which suggests that it is

3. Closet Business-As-Usual Investing

an inherent trait of such methodologies and even if we tweak the inputs as long as they represent the same fundamental characteristics we would end up with this behaviour. Greenifying a portfolio is indeed a free lunch if the investor is looking to reap labelling benefits with no desire to actually deviate from the reference benchmark. Any investor seeking genuine impact should be worried that beyond a 'feel-good' effect the climate product is de facto the ever-so-familiar cap weighted benchmark with a paper thin layer of green paint.

Faced with this difficulty, we believe that it would be useful to set a threshold for qualifying true green strategies. It seems fairly natural to consider that where less than 50% of the weight of constituents is determined by climate metrics, the strategy should not be marketed as a genuine climate strategy.



4. Blurred Signals

4. Blurred Signals

Next we turn our attention to the consistency of stock-level signals. Specifically, we want to assess if the signals sent through portfolio weights are consistent over time. Having inconsistent signals has self-evident undesirable effects: if firms can see that bad behaviour is not penalised, the incentive to improve climate performance will be weak.

One such inconsistency that investors should be wary of is to have stock weights increase when carbon performances deteriorate. We will term companies with deteriorating emissions performance as 'deteriorators' and assess the issue through the percentage of deteriorators that enjoy increased portfolio weights i.e., from the perspective of firms, they are being rewarded despite declining climate performance. Understandably, such an outcome would incentivise indifference to investor impact efforts at best.

In practice we define deteriorator stocks as stocks which have moved to a higher carbon measure decile from a lower carbon measure decile between two observation dates. The carbon deciles are defined within each Scientific Beta climate impact classification sector using the carbon metrics used in the construction of each strategy. This way we stay metric-agnostic. We use deciles to qualify a material change in carbon performance to avoid taking into account the noise of small variations in carbon measures. Finally, we measure the effect within peer groups in terms of activities and emissions impact.

We measure the presence of deteriorators on an annual basis in June, after the stylised strategies are rebalanced. We calculate the percentage of deteriorator stocks that have seen their weight increase. The increase in weight must be higher than 0.001bp (i.e., 10^{-8}) to filter out extremely small variations. We show reported averages values from June 2011 to June 2020 in Table 7.

Table 7: Average percentage of deteriorators increasing in weights by strategy type

Strategy type	Type T1	Type O1	Type T2	Type O2
Weighting scheme	Tilt	Optimised	Tilt	Optimised
ESG score integration	No ESG score		Include ESG score	
Percentage of deteriorators with increased weight	**33.5%**	**36.5%**	**40.9%**	**29.2%**

We report results for each strategy type, averaging across the 8 different climate scores we maintain. Our results thus provide a complete picture across the 8 climate metrics. We note that results align very closely across the 8 metrics so that averaging does not hide relevant information. We assess impact consistency measures once a year in June from 2011 to 2020 and report the average value. We thus provide a view on impact consistency observed on average over one decade. Each strategy is assessed on the specific carbon metric used in the score tilting or optimisation to ensure they have improved in 'greenness' at the portfolio level.

We observe that around 35% of deteriorators on average are rewarded with an increase in weight across our taxonomy – with no strategy type avoiding the issue. The signal sent is indeed blurred when more than one-third of the companies with sub-par carbon performances not only go unpunished but are instead rewarded with a higher weighting.

To make matters worse, it would be overly optimistic to expect the issue to be mitigated when we consider actual index methodologies: in the sample of methodologies we analysed we have not found any safeguard that would prevent this behaviour from emerging. Rules governing weighting are

4. Blurred Signals

overwhelmingly focused on point-in-time characteristics, with little consideration for changes in climate performance indicators. When strategies have a temporal dimension we have found that the rules are applied to an aggregate group of securities and not at stock level. Consequently, there is no guarantee of consistency at the stock level.

Table 8: Index rules analysis of deteriorator mitigation mechanisms

Provider	MSCI			FTSE		S&P DJI		STOXX	Euronext
Product	Low Carbon Target	Climate Change	Climate Paris Aligned	Global Climate	Low Carbon Select	Carbon Efficient	Paris Aligned and Climate Transition	CTB & PAB	Low Carbon PAB
Mechanism to prevent weight increase for a deteriorator at firm level	None	None	None	None	None	None	None	None	None
Accounts for changes in climate performance or for emission targets	None	None	Increases *aggregate weight* of firms with emissions reduction targets & decreased past intensity	None	None	None	Increases *aggregate weight* of firms with emissions reduction targets & decreased past intensity	Under-weighting of firms without published Science Based Targets	None

Constraints are documented from publicly-disclosed index rules from their respective index providers. The information is accurate as of end of April 2021.

Furthermore, as we look at the difference between carbon metrics types, we observe the risk of underestimating deteriorators. One can consider that climate scores that are normalised by capital market values are not good measures of climate performance (see Ducoulombier and Liu, 2021), since they artificially reduce intensities when firm values increase. For example, in the case of enterprise value including cash, issuing bonds or equity would inflate the denominator in the carbon intensity formula and result in 'improved' climate scores; so would positive performance on secondary markets. More generally, economic intensity metrics relying on capital market values (rather than revenues for example) provide opportunities for firms to focus on boosting market valuation as an alternative to reducing emissions, in which case we end up in the undesirable situation of financing the same amount of carbon emissions despite improving firm-level carbon metrics.

Thus, the deteriorator issues are artificially reduced for strategies that use market-value-related scores as both weights and climate scores increase in tandem with increasing valuations. If we consider only more reasonable climate metrics that do not express emissions in relation to market value, the percentage of deteriorators reaches even higher levels of about 40%.

4. Blurred Signals

Table 9: Average percentage of deteriorators increasing in weights by normalisation approach of carbon measure

Type of carbon metric normalisation	Normalised by non-market value related metrics	Normalised by market value related metrics
Percentage of deteriorators with increased weight	40.8%	29.9%

Market-value-related carbon metrics are carbon measures normalised by market capitalisation and enterprise value including cash. Non-market-value related metrics are normalised by revenues or unadjusted emissions. We assess impact consistency measures once a year in June from 2011 to 2020 and report the average value. We thus provide a view on impact consistency observed on average over one decade. Each strategy is assessed on the specific carbon metric used in the score tilting or optimisation to ensure they have improved in 'greenness' at the portfolio level.

The analysis of deteriorators provides simple results and focusses on issues with stocks that constitute the worst case in terms of emissions dynamics. The questions of how climate strategies account for the dynamics of climate performance at the firm level is a more general one. Increasing the weight of a stock with deteriorating climate performance does not send an appropriate signal, but neither does reducing the weight of a stock with improving climate performance. To assess the link between firm-level changes in climate performance over time and the weight changes of the corresponding stock in climate strategies, we again resort to weighting determinant analysis. Instead of considering levels of weight and levels of stock characteristics, we now look at changes in weights and changes in stock characteristics. In particular, we have conducted WDA on changes in weights between two rebalancing dates, i.e. we regress year-on-year changes in weights against year-on-year changes in characteristics. Coefficients with statistical significance at the 5% level are reported in bold in Table 10 below.

Table 10: WDA regression of changes portfolio weights against changes in key characteristics

Strategy type	Type T1	Type O1	Type T2	Type O2
Weighting scheme	Tilt	Optimised	Tilt	Optimised
ESG score integration	No ESG score		Include ESG score	
Impact on changes in weight in basis points				
Intercept	0.01	0.08	0.02	0.07
Impact of changes in market cap (1 Std Dev increase)	**3.12**	**2.98**	**3.34**	**3.09**
Impact of changes in climate score (1 Std Dev increase)	0.07	0.06	0.02	0.09
Impact of changes in ESG score (1 Std Dev increase)	0.02	0.01	**1.76**	**2.03**

We report results for each strategy type, averaging across the eight different climate scores we maintain. Our results thus provide a complete picture across all the climate metrics. We note that results align very closely across them all, so that averaging does not hide relevant information. We assess impact consistency measures once a year in June from 2011 to 2020 and report the average value. We thus provide a view on impact consistency observed on average over one decade. Each strategy is assessed on the specific carbon metric used in the score tilting or optimisation to ensure they have improved in 'greenness' at the portfolio level.

We observe that coefficient estimates associated with changes in climate score are not statistically significant. We do not see any effect of climate score changes on how weights evolve. Instead, the evolution of stock weights in these strategies is indifferent to changes in climate performance. Recall from the introduction that a key motivation for climate investing is to "reward companies for their efforts in reducing their carbon footprint" and "discipline" those that do not make the necessary efforts (see Andersen, Bolton, and Samama 2016). Clearly, the weighting schemes we analyse do not contain such rewards. Instead, the successful efforts of companies are irrelevant for the evolution of strategy weights. In contrast to the irrelevance of climate score changes, changes in market capitalisation are a hugely important driver of changes in weights, with changes in ESG score being significant in the strategies with ESG integration.

4. Blurred Signals

For robustness we also look at sorting-based WDA results on the changes in weight as reported in Table 11.

Table 11: WDA: Sorting analysis of the spread in changes in characteristics between the top quintile and bottom quintile portfolios

Stylised portfolio type	Type T1	Type O1	Type T2	Type O2
Weighting scheme	Score tilt	Optimised	Score tilt	Optimised
ESG score integration	No ESG score		Include ESG score	
Index weight change quintile portfolios spreads (difference in weighted average z-score of top quintile - bottom quintile)				
Market cap change spread	4.07	3.65	3.16	2.90
Climate score change spread	0.05	0.05	0.06	0.05
ESG score change spread	0.07	0.09	1.05	0.93

The results are consistent with the regression based WDA. Market capitalisation remains the overwhelming driving force behind stock weights.

The empirical result is striking: the strategies are basically indifferent to the evolution of climate performance and thus fail to send any clear signal to companies. The climate considerations are playing second fiddle to market capitalisation and even ESG considerations. It is not clear that companies can distil any actionable insight from the signals sent by the allocations of these climate strategies. Any changes in carbon performance can be overridden by market volatility, which firms do not control to a large extent. Firms are well incentivised to continue operating with no regard for climate performance since it does not seem to guarantee them better representation in climate investment products. Meanwhile, the business transformations necessary to tackle climate change are onerous and risky. Climate investing is not spurring firms to take the initiative in commencing meaningful transformations, with signals that are timid at best and confusing at worst. If a firm stays out of the limelight of public scrutiny, climate investing, as it is, does not move the needle in how financing is afforded to climate leaders.

Here again, from a normative viewpoint it seems interesting to provide a threshold that would lead one to consider that the strategy, due to the greenwashing risk that it presents at stock level, turns out to be harmful to the climate. A figure greater than the threshold of 5%, which is an outlier reference that is fairly commonly used in finance, could be selected. As such, any climate strategy or benchmark that sees the weight of more than 5% of the climate deteriorators increase should be considered to be practicing greenwashing at stock level. More generally, if the average increase in the weights of climate deteriorators is equivalent to that of climate improvers[14] (i.e., if there is no significant difference), it should be considered not only that the strategy is subject to portfolio greenwashing, but also that this greenwashing leads to the promotion of a consequence that has a potentially negative impact on the climate.

14 - We present a comparison of the weights and weight changes for deteriorator stocks (stocks with worsening climate metric) and for improver stocks (stocks with improving climate metrics) in stylised climate strategies in the appendix (see Appendix 5).

5. Industry Compression

5. Industry Compression

How are climate strategies achieving their greenness in practice? After all, if the portfolio metric is improved significantly, then some 'efficient' reallocation has necessarily taken place. The significant improvement in carbon measures come at a price that is not immediately apparent. When we look at the distribution of carbon emissions, certain industries are responsible for a large portion of the weighted average carbon measures of the reference universe, namely the Energy, Utilities and Materials sectors. We have already discussed the paradoxical relationship between the Energy sector's significant contribution to environmental innovations and the general shunning of the sector in sustainable investment. We would like to focus on another key sector of the transition toward a green economy: the electricity sector.

In the analytics presented below we define the electricity sector as stocks belonging to the Electricity sector in the Scientific Beta carbon-orientated classification.

Electrical utilities tend to report high carbon emissions with average or below average denominators in common carbon metrics. As a consequence, and especially in a market cap anchored context, targeting the electricity sector is the path of least resistance to achieving attractively large reductions in carbon metrics. The result is a drastic underweighting of the electricity sector in climate strategies as reported in Table 12.

Table 12: Representation of the electricity sector by strategy type

Stylised portfolio type	Type T1	Type O1	Type T2	Type O2
Weighting scheme	Score tilt	Optimised	Score tilt	Optimised
ESG score integration	No ESG score		Include ESG score	
Electricity sector absolute active weight	-2.21%	-2.47%	-1.07%	-1.42%
Electricity sector relative active weight (percentage under or overweight relative to cap-weighted index)	-81.04%	-90.51%	-39.10%	-52.11%

We report results for each strategy type, averaging across the 8 different climate scores we maintain. Our results thus provide a complete picture across the 8 climate metrics. We note that results align very closely across the 8 metrics so that averaging does not hide relevant information. We assess impact consistency measures once a year in June from 2011 to 2020 and report the average value. We thus provide a view on impact consistency observed on average over one decade. Each strategy is assessed on the specific carbon metric used in the score tilting or optimisation to ensure they have improved in 'greenness' at the portfolio level. Electricity sector is from the Scientific Beta climate impact sector classification. Note: Index products may deviate from stylised strategies in important ways. Results derived for stylised strategies may not be applicable to index products, in particular in the case where index products employ additional constraints or rules which are not accounted for in the stylised strategies.

With relative reduction of up to 91%, the de facto outcome is partial to total divestment. This is not a desirable outcome. Firms in key sectors such as electricity need to have access to funding to transition their activities. We can hardly do away with electricity when electrification of energy use, notably in transport and industry, are central requirements in global decarbonisation pathways (IPCC, 2018). Depriving key sectors of funding is not a reasonable forward-looking investment policy, nor is it sustainable at the scale of entire economies. Outright divestment of the electricity sector can greenify investment portfolios but cannot greenify the real economy. Shunning investments in an entire sector also conflicts with the key recommendations from economic models of investor impact (see the Introduction).

Because we are looking at stylised strategies, a caveat of this analysis would be that real climate strategies can avoid industry compression issues by having sector constraints. However in our review of index rules we have found that sector constraints are often too loose and/or lacking in granularity to provide effective mitigation. In Table 13 we summarise some of the sector constraints applied in industry offerings.

5. Industry Compression

Table 13: Examples of sector constraints implemented in climate strategies

Provider	MSCI			FTSE		S&P DJI		STOXX	Euronext
Product	Low Carbon Target	Climate Change	Climate Paris Aligned	Global Climate	Low Carbon Select	Carbon Efficient	Paris Aligned Climate Transition	CTB & PAB	Low Carbon PAB
General sector weight constraint	+/- **2%** (GICS Level 1, 11 groups)	**None**	+/- **5%** (GICS Level 1, 11 groups)	**None**	+/- **5%** (ICB Level 1, 11 groups)	+/- **0%** GICS Level 2, 24 groups)	**None** (no explicit constraint on weights)	+/- **5%** (NACE Level 1, 21 groups)	+/- **0%** (ICB Level 2, 20 groups, non-green pocket)
Exception for the energy sector	**Unlimited under-weight**	None	**Unlimited under-weight**	None	**Unlimited under-weight**	None	None	None	None
Potential reduction of the utilities sector weight	**70%**	**100%**	**100%**	**100%**	**100%**	0%	**100%**	**100%**	0%
Potential reduction of the electricity sector weight	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Constraint on group with High Climate Impact	None	None	Weight ≥ benchmark weight	None	None	None	Revenue constraint	Weight ≥ benchmark weight	Weight ≥ benchmark weight

Constraints are documented from publicly disclosed index rules from their respective index providers, the information is accurate as of end of April 2021.

One shortcoming of the sector constraints is the lack of granularity in their definition. We illustrated this with the permissible theoretical reductions in the Utilities sector and Electricity sector. The sector constraints are commonly defined at the broadest level: for example 'Sector' for GICS or 'Industry' for ICB, or the second broadest level: 'Industry Group' for GICS or 'Supersector' for ICB. It is relevant if we consider the Utilities to be the group of interest. However in our case the electricity sector is only part of the Utilities sector, which can also contain water utilities, gas utilities and waste disposal. Thus even a strict zero deviation rule at level 2 allows for reallocation from electricity to other types of utilities that are typically less carbon intensive and in no way contribute to the electrification of energy use. Therefore, seemingly strict rules can fail to preserve key industries like electricity. We report the structures of Utilities in GICS and ICB in Tables 14 and 15.

Table 14: Structure of the Utilities sector in GICS

Sector	Industry Group	Industry	Sub-industry
55 Utilities	5510 Utilities	551010 Electric Utilities	55101010 Electric Utilities
		551020 Gas Utilities	55102010 Gas Utilities
		551030 Multi-Utilities	55103010 Multi-Utilities
		551040 Water Utilities	55104010 Water Utilities
		551050 Independent Power and Renewable Electricity Producers	55105010 Independant Power Producers & Energy Traders
			55105020 Renewable Electricity

Source: GICS Methodology - MSCI Inc.

5. Industry Compression

Table 15: Structure of the Utilities sector in ICB

Industry (Level 1)	Supersector (Level 2)	Sector (Level 3)	Subsector (Level 4)
Utilities	Utilities	Electricity	Alternative Electricity Conventional Electricity
		Gas, Water and Multi Utilities	Multi Utilities Gas Distribution Water
		Waste and Disposal Services	Waste and Disposal Services

Source: FTSE Russell

Another shortcoming of sector constraints is the inadequacy of a single threshold for all sectors. The most common deviation threshold is +/-5% relative to the reference universe, which may appear appropriate for the larger economic sector; however the key sectors we are concerned with are typically weighted less than 5%.

The sector constraints we found in climate index methodologies are either level 1 or level 2 in GICS, ICB or NACE. As of end of May 2021, the sector weights in comparable Developed Markets Cap weighted benchmarks are as follows:
- GICS[15]: Level 1(Sector): Utilities 2.87%, Level 2 (Industry Group): Utilities 2.87%
- ICB[16]: Level 1 (Industry): Utilities 2.92%, Level 2 (Supersector): Utilities 2.92%
- NACE[17]: Level 1(Section): D - Electricity, Gas, Steam and Air Conditioning Supply 2.65%, Level 2 (Division) 35. Electricity, gas, steam and air conditioning supply, 2.65%, Level 3 (Group) 35.1. Electric power generation, transmission and distribution 2.45%

We can see that a +/-5% percentage point constraint allows for total divestment and a +/-2% percentage point constraint can lead to a 68% to 81% reduction in the weights of Utilities. These theoretical bounds are consistent with our empirical observations in the stylised strategies.

We provide another illustration of this in Table 16, using the Refinitiv Business Classification that reasonably approximates the classifications used in the index rules we analysed. We show the implied permissible bounds of sector weights.

Table16: Examples of sector deviation permissible under a common sector constraint threshold

Global Developed Markets universe — June 2020		Permissible weight as a percentage of current sector weight	
Sectors	Benchmark weight	With a +/-5% percentage point constraint	
		Min.	Max.
Energy	3.44%	**0%**	245%
Basic Materials	4.20%	**0%**	219%
Industrials	11.10%	55%	145%
Cyclical Consumer	13.03%	62%	138%
Non-Cyclical Consumer	8.42%	41%	159%
Financials	15.49%	68%	132%
Healthcare	14.82%	66%	134%
Technology	23.46%	79%	121%
Telecoms	2.58%	0%	294%
Utilities	3.47%	**0%**	244%

Based on The Refinitiv Business Classification

15 - GICS sector weights are derived from MSCI World Index as of 31 May 2021.
16 - ICB sector weights are derived from FTSE Developed Index as of 31 May 2021.
17 - NACE sector weights are derived from SciBeta Developed Cap-Weighted Index as of the June 2021 review.

5. Industry Compression

Total divestment is still possible for Energy, Basic Materials and Utilities while enforcing a threshold of 5% and we are looking at the rule being applied at the broadest level. The effect would be even more limited if the rule is applied at a more granular level. In short, climate strategies are not protected from total sector divestment despite having seemingly reasonable sector constraints.

Another type of sector-related constraint found in climate alignment products – notably those targeting compliance with the EU Paris-Aligned Benchmarks minimum requirements – is the constraint on the aggregate weight of high climate impact sectors. To test the effectiveness of such constraints we adapt the stylised strategies with an ex post adjustment of the weights of high climate impact sectors to match the exposure of the reference universe.

As we can see in Table 17, the constraint is not binding in the slightest, which is expected given that the average weight of the group of high climate impact sectors is 60% in unadjusted strategies, while the benchmark exposure is 64%. High climate sector is such a broad subset of the investment universe that matching the overall exposure is achievable at little cost in terms of overall greenness score (as fed back to the regulator by Amenc and Ducoulombier, 2020).

Table 17: Effect of high climate impact sectors constraints on electricity sector compression

Strategy type	Type T1	Type O1	Type T2	Type O2
Weighting scheme	Tilt	Optimised	Tilt	Optimised
ESG score integration	No ESG score		Includes ESG score	
Unconstrained strategies				
Electricity sector absolute active weight	-2.21%	-2.47%	-1.07%	-1.42%
Electricity sector relative active weight	**-81.04%**	**-90.51%**	-39.10%	-52.11%
Strategies with constraint on high climate impact sectors				
Electricity sector absolute active weight	-2.15%	-2.44%	-1.01%	-1.36%
Electricity sector relative active weight	**-79.02%**	**-89.40%**	-37.10%	-49.87%

We report results for each strategy type, averaging across the 8 different climate scores we maintain. Our results thus provide a complete picture across the 8 climate metrics. We note that results align very closely across the 8 metrics so that averaging does not hide relevant information. We assess impact consistency measures once a year in June from 2011 to 2020 and report the average value. We thus provide a view on impact consistency observed on average over one decade. Each strategy is assessed on the specific carbon metric used in the score tilting or optimisation to ensure they have improved in 'greenness' at the portfolio level. Electricity sector is from the Scientific Beta climate impact sector classification.

As we can see in Table 17, the issue of divestment from electricity remains intact. With this constraint in place, the improvement is arguably immaterial.

To refine our analysis of how much of the portfolio decarbonisation is achieved through sector allocation, we perform a decomposition analysis of the carbon metric across TRBC sectors in the spirit of Brinson, Hood and Beebower (1986). We decompose each strategy's reduction in carbon measure relative to the cap-weighted reference into three effects: sector-weighting effect, intra-sector stock-selection effect and interaction effects. Through this analysis we try to shed light on the quality of the decarbonisation i.e., to measure the extent to why the reduction simply relies on underweighting high carbon sectors.

5. Industry Compression

To keep results comparable across different carbon metrics we express the sums of stock, sector and interaction effects in % of the total reduction in carbon metric achieved by each strategy in Table 18.

Table18: Decomposition of portfolio level carbon metrics reduction into BHB-like effects expressed in percentage of the absolute reduction achieved

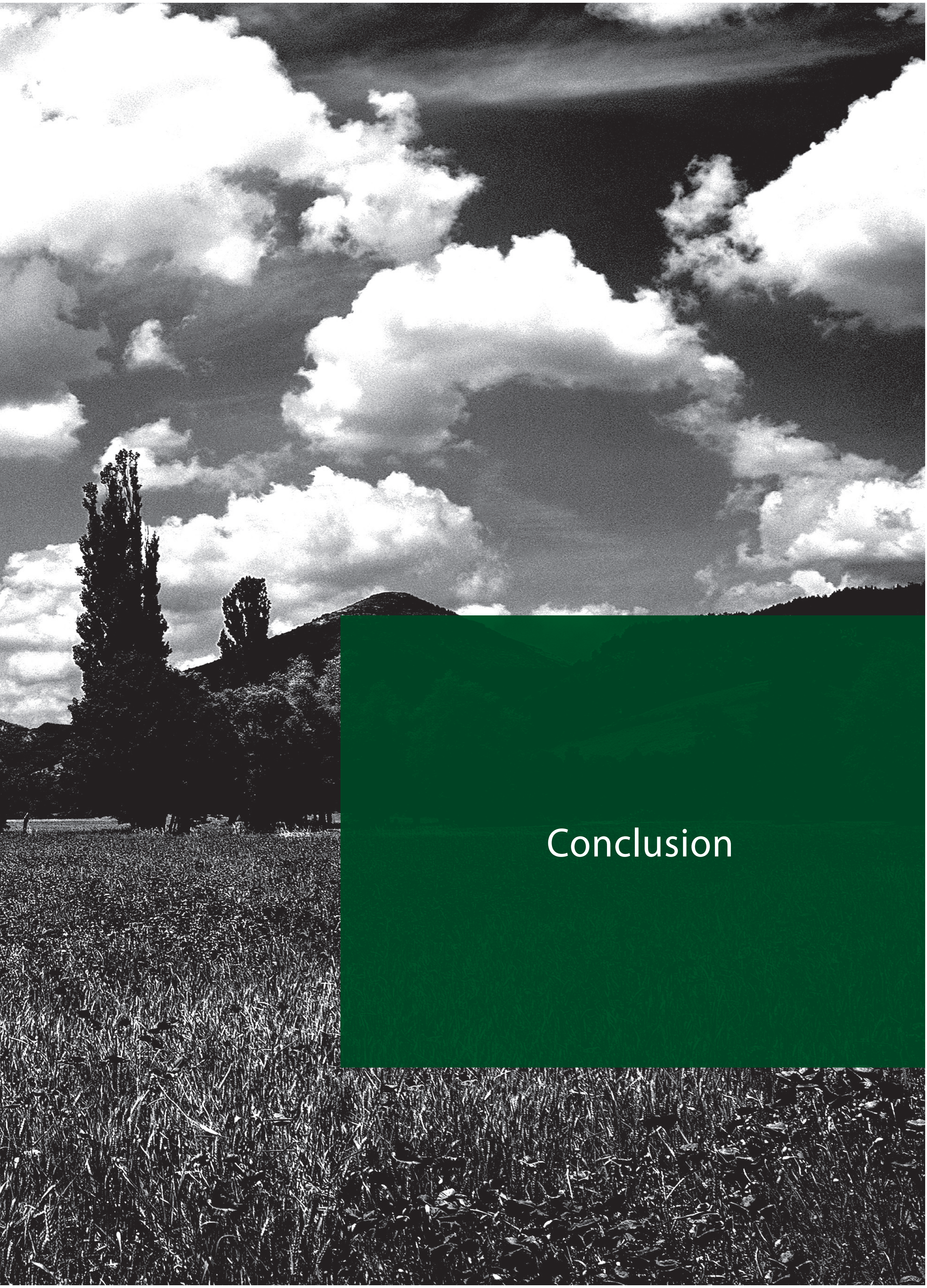
Strategy type	Type T1	Type O1	Type T2	Type O2
Weighting scheme	Tilt	Optimised	Tilt	Optimised
ESG score integration	No ESG score		Includes ESG score	
Sector effect	64%	49%	61%	42%
Stock effect	90%	77%	90%	78%
Interaction effect	-54%	-26%	-51%	-20%

We report results for each strategy type, averaging across the 8 different climate scores we maintain. Our results thus provide a complete picture across the 8 climate metrics. We note that results align very closely across the 8 metrics so that averaging does not hide relevant information. We assess impact consistency measures once a year in June from 2011 to 2020 and report the average value. We thus provide a view on impact consistency observed on average over one decade. Each strategy is assessed on the specific carbon metric used in the score tilting or optimisation to ensure they have improved in 'greenness' at the portfolio level.

We observe that around 40% of the positive contribution to reduction in carbon metrics can be attributed to strictly allocating between sectors regardless of company-level carbon performance. We can see the cumulative interaction effect attenuating the carbon metric improvement: this results from the high-carbon sector such as Energy, Basic Materials and Utilities being heavily underweighted while simultaneously its sector-level weighted average carbon metric has been drastically reduced.

Arguably a more robust decarbonisation structure would achieve most of the reduction through stock selection within peer groups such as sectors. Industry compression is a significant threat to sufficient allocation of capital to key sectors that need to step up to the challenges of climate transition. By relying on industry divestment to achieve decarbonisation, climate strategies retreat from key sectors (Energy, Utilities) to pile into structurally low-carbon sectors like Information Technology or Telecommunications, which ultimately do not have a direct impact on reducing carbon emissions.

Here too, normative guidelines should probably be promoted. It seems impossible to qualify as a climate alignment strategy a benchmark or a portfolio whose exposure to a key (sub)sector such as Electricity sees its financing (and therefore its weight) reduced by more than 25% compared to its cap-weight.



Conclusion

Conclusion

As the stakes of mitigating climate change become more apparent in the public consciousness, more and more investors are trying to make a positive impact on climate change through their investments. However, as investors pursue climate objectives to decarbonise investment portfolios, the real-world impact of portfolio decarbonisation remains unclear. Achieving large portfolio-level carbon metric improvements is attractive for product marketing, but it is not guaranteed to translate into meaningful real-world impacts.

We set out to assess the consistency with impact objectives of the portfolio decarbonisation achieved by existing climate investing strategies. In order to synthesise the heterogeneity in specifications of green offerings in the industry we proposed a taxonomy of climate strategies to generalise our analysis, and implemented stylised strategies that reflect popular weighting schemes in climate investing strategies. Our analysis of these strategies revealed three key shortcomings that introduce greenwashing risks in climate strategies.

The three types of portfolio greenwashing risks we identified are the non-materiality of climate considerations, the inconsistency of stock-level signals and the underweighting of key industries. The non-materiality of climate considerations transpires through the domination of market capitalisation as the key driver of portfolio weights. The impact of climate scores on weights is comparatively negligible. In addition, the evolution of stock weights over time in such strategies is not appropriate to send consistent signals to firms. We observe a significant proportion of stocks that benefit from weight increases despite deteriorating climate performances . Finally, the compression of key industries is another significant concern. Important sectors associated with high emissions, such as electricity production, can be drastically underweighted in climate strategies. Such underweighting allows higher aggregate green scores to be displayed for the portfolio, but does not address how electricity producers should be funded to support electrification of energy and incentivised to produce cleaner electricity. We have also assessed index methodologies for potential safeguards that would prevent the problems described for stylised strategies, and found that methodologies lack dedicated mechanisms that would avoid increasing weights in deteriorators or severe underweighting of the electricity sector.

We checked that our results are robust across different strategy specifications. The issues we identified are general in nature and not specific to a single approach. Since climate strategies do not address such greenwashing risks in their design, it is perhaps not surprising that we detect these issues across a large number of specifications. For example, incorporating emission trajectories and constraints on high climate impact sectors, as required by EU regulation for Paris-Aligned Benchmarks, does not address any of the problems we document. This is clear from analysing the constraints imposed by the regulation and thus, unsurprisingly, shows in strategies that we adjust to respect such constraints.

We proposed key indicators that help in diagnosing greenwashing by formulating how inconsistencies can manifest themselves through portfolio weights. Our analysis can be easily replicated and adapted for purposes of due diligence for climate investing strategies. They only rely on portfolio weights, which investors should be able to obtain for any candidate climate strategy they are considering, and a measure of carbon performance, where different investors may prefer different metrics. Due diligence

Conclusion

of investment products is historically geared towards analysing performance and financial risks. For investors who subscribe to the impact objectives of net-zero initiatives, it is equally important to analyse greenwashing risks.

Our recommendation for climate conscious investors is to stay vigilant when they are offered the 'warm glow' of portfolio-level improvement in climate metrics and to look beyond cosmetic improvements. They should instead seek to have an impact on corporate behaviour through the synergistic action of engagement efforts combined with consistent capital allocation decisions. The danger is that they pay for 'feel good' products that could in fact induce complacency and delay meaningful action in the face of the urgency of addressing climate change. The implications for climate investing due diligence are clear: when investors select green products, they need to give special attention to how greenness is achieved. Impact consistency involves making sure that firms with deteriorating carbon performance are not rewarded, that key industries remain properly represented and funded, and that climate considerations are a meaningful driver of capital allocation.

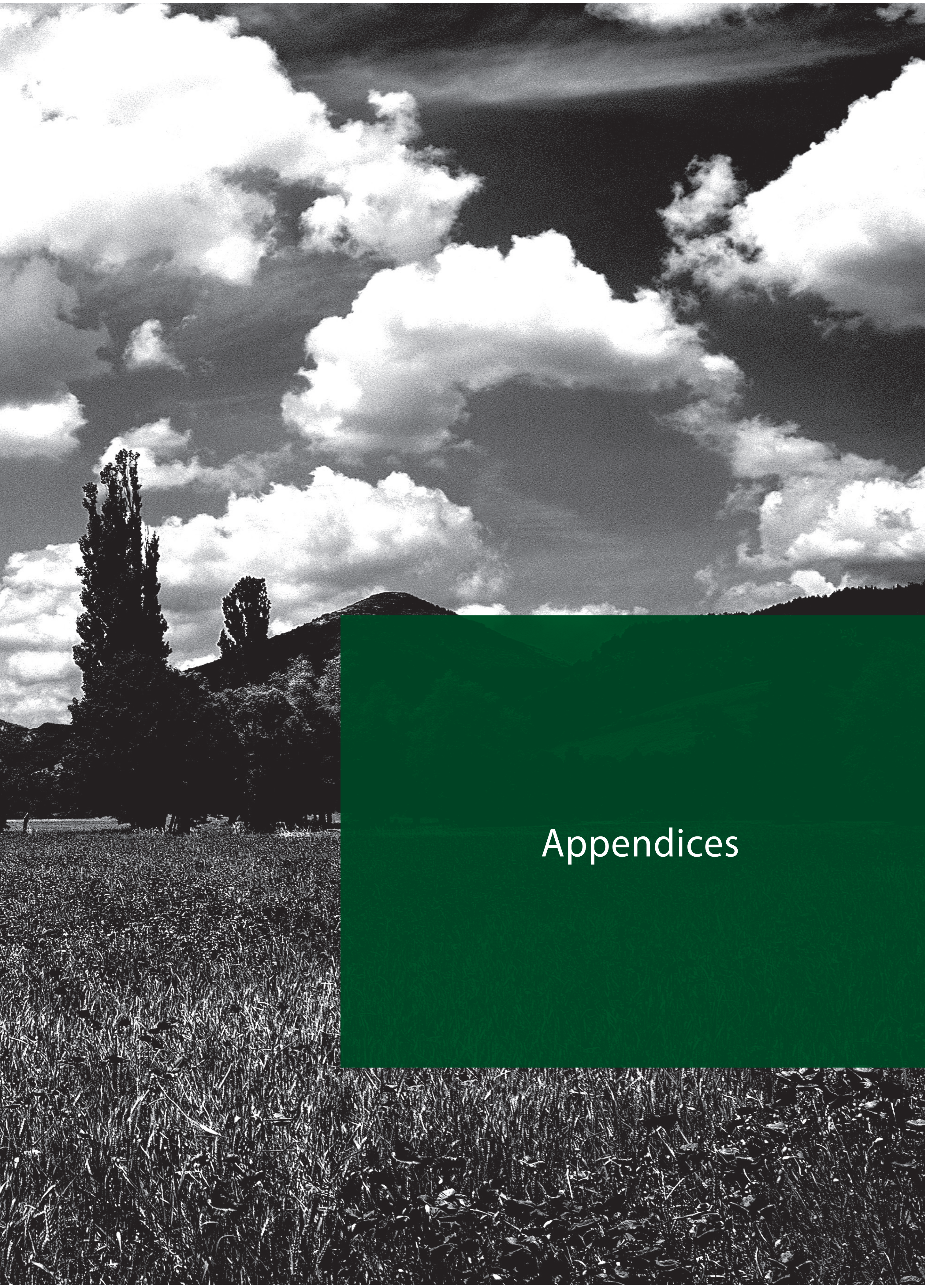
We would also like to reiterate that the objective of this report is not to stigmatise any particular commercial offerings. As such, we again emphasise that some of these were mentioned only to show that the stylised strategies used in our study are genuinely relevant for analysing current practices. It is clear that the real problem highlighted in this report is not an intention to do harm, or even a lack of real attention to the climate question, but that of the negative consequences of applying a portfolio construction method that mixes up financial and climate data on the potential impact of climate investment strategies.

By wanting to reconcile ambitious carbon intensity reduction objectives with tracking error constraints and/or compliance with cap-weighting hierarchies, the traditional green portfolio construction approach fails to offer strategies that are consistent with the desire to achieve climate engagement from investors.

In this context, and beyond the individual due diligence that we recommend, we think that it is time for collective consideration of the necessary paradigm shift in climate investing. It is not possible to achieve a climate revolution by continuing to stick to traditional benchmarks. It is only by freeing climate investment from tracking error minimisation constraints and objectives that we can hope to have benchmarks that are consistent with climate alignment objectives.

To succeed in this change, which is essential to effectively mobilise the financial industry for clients, the regulator should draw up clear rules for the fight against portfolio greenwashing. It should avoid promoting green labels based on regulations that in no way protect investors against greenwashing risks, as is the case with the likes of the EU Paris-Aligned Benchmark regulation.

As part of this consideration and to bolster the fight against portfolio greenwashing, we suggest that when climate considerations represent less than 50% of the determinants of the weight of the stocks in the portfolio that is presented as representing an alignment strategy, then the portfolio should be considered to be subject to a significant risk of greenwashing and it should not be possible to consider or label it as climate-friendly or aligned.



Appendices

Appendices

Appendix 1: Rating-Based Climate-Score Strategies

We have also looked at other ways of defining a climate score that are independent of carbon emissions. Such approaches are not represented in the products we analysed, unsurprisingly given the importance of carbon emissions metrics in regulatory frameworks and climate advocacy initiatives. In Table A1 we report key results of type T and O strategies with MSCI IVA sub scores taken as climate score: the Climate Change sub score and the Environmental pillar sub score. The table shows the key results of those rating-based climate score strategies.

Table A1: Key greenwashing indicators for rating based climate score strategies

Global Developed Markets Universe	Type T1	Type O1	Type T2	Type O2
Weighting scheme	Score tilt	Optimised	Score tilt	Optimised
ESG score integration	No ESG score		Include ESG score	
Electricity sector relative active weight (percentage under or overweight relative to cap-weighted index)	1%	-12%	6%	3%
Percentage of deteriorators with increased weight	25%	19%	31%	24%
Impact on weights in basis points				
Intercept (~average weight)	**6.4**	**6.6**	**6.5**	**6.5**
Impact of market cap (1 Std Dev increase)	**13.1**	**12.7**	**13.2**	**12.4**
Impact of climate score (1 Std Dev increase)	**2.9**	**3.1**	**1.7**	**1.8**
Impact of ESG score (1 Std Dev increase)	-0.1	-0.1	**2.3**	**2.3**

We report results for each strategy type, averaging across the eight different climate scores we maintain. Our results thus provide a complete picture across these climate metrics. We note that results align very closely across the all of the metrics so that averaging does not hide relevant information. We assess impact consistency measures once a year in June from 2011 to 2020 and report the average value. We thus provide a view on impact consistency observed on average over one decade. Each strategy is assessed on the specific carbon metric used in the score tilting or optimisation to ensure they have improved in 'greenness' at the portfolio level.

We observe an improvement in the preservation of the electricity sector with no compression to around 10% reduction. The issue of deteriorators is still present with on average 20% to 30% of deteriorators increasing in weight. The impact of climate score is still small compared to market capitalisation: market capitalisation is around four times as meaningful in determining portfolio weights. The impact of ESG score is more important in the mixed score strategies.

Appendices

Appendix 2: Path-Based Stylised Strategies

Another type of climate strategy is what we qualify as 'path-based' strategies. Notable examples of such strategies are those deployed in European Union Climate Transition Benchmarks (CTB) or Paris Aligned Benchmark (PAB) compliant products. The prevalence of such products is on the rise as reflected in our review of European climate ETFs.

They represent an additional layer of constraint compared with standard type T and O strategies. They leverage aspects of type O strategies while also incorporating the time-sensitive dimension of complying with a minimum decarbonisation trajectory. It could be postulated that the issue of deteriorators in particular could be solved by a trajectory sensitive methodology: we are taking into account the variation over time of climate scores.

We tested this hypothesis by building path-based stylised strategies that include key characteristics of path-based methodologies. We target at least a 7% per annum decarbonisation trajectory relative to a base year. Simultaneously the strategies target at minimum a 50% decarbonisation relative to the reference cap weighted index (to align with key requirements for PAB-compliant products). To reflect the high climate impact sector constraints of CTB/PAB we also maintain equal or higher cumulative exposure to these sectors relative to the reference cap weighted index. Finally we minimise tracking error with respect to the cap weighted reference index, in line with industry practice. For the climate scores we use the same eight versions of carbon metrics as in the type O1 and T1 stylised strategies, this time with no mixed objective scores as the path based methodology put emphasis on decarbonising a emission based metric. The key results are reported in Table A2.

Table A2: Key greenwashing indicators for path-based strategies

Global Developed Markets Universe	Type T1	Type T2	Type O1	Type O2	Type P
Weighting scheme	Score tilt	Optimised	Score tilt	Optimised	Path Optimised
ESG score integration	No ESG score		Include ESG score		No ESG score
Electricity sector relative active weight (percentage under or overweight relative to cap-weighted index)	-81.04%	-90.51%	-39.10%	-52.11%	-59.99%
Percentage of deteriorators with increased weight	33.5%	36.5%	40.9%	29.2%	37.6%
Impact on weights in basis points					
Intercept (~average weight)	**6.4**	**6.4**	**6.4**	**6.5**	**6.4**
Impact of market cap (1 Std Dev increase)	**13.1**	**11.9**	**13.4**	**12.1**	**12.5**
Impact of climate score (1 Std Dev increase)	**1.7**	**1.7**	**1.2**	**1.0**	**1.1**
Impact of ESG score (1 Std Dev increase)	0.1	0.0	**3.6**	**3.6**	**0.0**

We report results for each strategy type, averaging across the eight different climate scores we maintain. Our results thus provide a complete picture across these climate metrics. We note that results align very closely across all metrics so that averaging does not hide relevant information. We assess impact consistency measures once a year in June from 2011 to 2020 and report the average value. We thus provide a view on impact consistency observed on average over one decade. Each strategy is assessed on the specific carbon metric used in the score tilting or optimisation to ensure they have improved in 'greenness' at the portfolio level.

We do not observe a material improvement of the presence of deteriorators increasing in weight: on average 37.6%. The reduction in compression of the electricity sector is in line with the lesser reduction in carbon metrics achieved by the path-based strategies: around 60% on average compared with an average of more than 80% for pure climate type O and T strategies. The inclusion of a decarbonisation path does not change the lack of materiality of the impact of climate score compared to market capitalisation.

Appendices

Appendix 3: Developed Markets Calendar Performance

Table A3: Calendar performance of stylised strategies and a selection of commercial climate indices

Calendar year performance (USD Total return index)		Climate indices						Stylised portfolios			
Year	MSCI World	MSCI WORLD LOW CARBON TARGET	MSCI WORLD CLIMATE CHANGE	MSCI WORLD CLIMATE PARIS ALIGNED	S&P Developed Carbon Efficient	S&P Developed Ex-Korea Climate Transition	S&P Developed Ex-Korea Paris-Aligned Climate	Type T1	Type O1	Type T2	Type O2
2011	-5.02%	-4.79%						-5.70%	-5.73%	-5.30%	-5.54%
2012	16.54%	17.42%			17.11%			18.23%	18.05%	15.63%	16.46%
2013	27.37%	27.22%			26.18%			28.56%	28.00%	27.37%	27.19%
2014	5.50%	5.91%	6.15%	7.51%	4.75%			6.23%	5.58%	5.16%	5.56%
2015	-0.32%	0.25%	1.79%	2.01%	0.22%			2.25%	1.93%	0.98%	1.37%
2016	8.15%	7.65%	7.09%	8.77%	7.58%			5.96%	6.69%	6.08%	7.03%
2017	23.07%	22.90%	24.44%	24.44%	23.57%	23.55%	24.62%	24.67%	24.71%	24.91%	24.85%
2018	-8.20%	-8.41%	-7.79%	-6.99%	-8.24%	-7.42%	-7.89%	-7.74%	-8.18%	-7.90%	-7.75%
2019	28.40%	29.27%	29.91%	30.10%	28.36%	31.25%	31.38%	30.18%	29.25%	31.37%	29.76%
2020	16.50%	17.09%	20.80%	18.77%	16.47%	20.62%	20.65%	17.45%	14.93%	18.09%	16.14%

We report results for each strategy type, averaging across the eight different climate scores we maintain. Our results thus provide a complete picture across these climate metrics. We note that results align very closely across all metrics so that averaging does not hide relevant information. Data on commercial products are sourced from public available resources of the respective index providers MSCI Inc. and S&P Dow Jones Indices.

We report MSCI World here as a broad cap-weighted reference. We observe that the performance of the stylised portfolios are broadly in line with comparable commercial products in Developed Markets. It should be noted that we limit commercial products to those where we could find returns data for at least four calendar years.

Appendices

Appendix 4: Robustness of the definition of deteriorators

We explored in Section 3 the issue of blurred signals while allocating to companies with deteriorating climate performance. We choose to define the carbon measure deciles within peer groups defined by their Scientific Beta climate impact sectors to compare firms with similar carbon activities.

To check the robustness of the concept of deteriorators we have also analysed results using other definitions of peer groups: using the TRBC sectors, using geographical peer groups[18] and not using any peer group.

Table A4: Robustness check on deteriorators definition

Strategy type	Type T1	Type O1	Type T2	Type O2
Weighting scheme	Tilt	Optimised	Tilt	Optimised
ESG score integration	No ESG score		Include ESG score	
Percentage of deteriorators with increased weight (Scientific Beta climate impact peer group)	**33.5%**	**36.5%**	**40.9%**	**29.2%**
Percentage of deteriorators with increased weight (TRBC sector peer group)	**33.8%**	**35.9%**	**41.7%**	**30.0%**
Percentage of deteriorators with increased weight (Scientific Beta Geographical block peer group)	**32.7%**	**36.5%**	**40.8%**	**31.0%**
Percentage of deteriorators with increased weight (No peer group)	**32.6%**	**36.8%**	**40.8%**	**30.2%**

We report results for each strategy type, averaging across the eight different climate scores we maintain. Our results thus provide a complete picture across these climate metrics. We note that results align very closely across all metrics so that averaging does not hide relevant information. We assess impact consistency measures once a year in June from 2011 to 2020 and report the average value. We thus provide a view on impact consistency observed on average over one decade. Each strategy is assessed on the specific carbon metric used in the score tilting or optimisation to ensure they have improved in 'greenness' at the portfolio level.

We observe that results are very similar across the board, indicating that the idea of deteriorators is robust in respect to the peer group chosen for its definition.

Appendix 5: Comparison of Deteriorators and Improvers

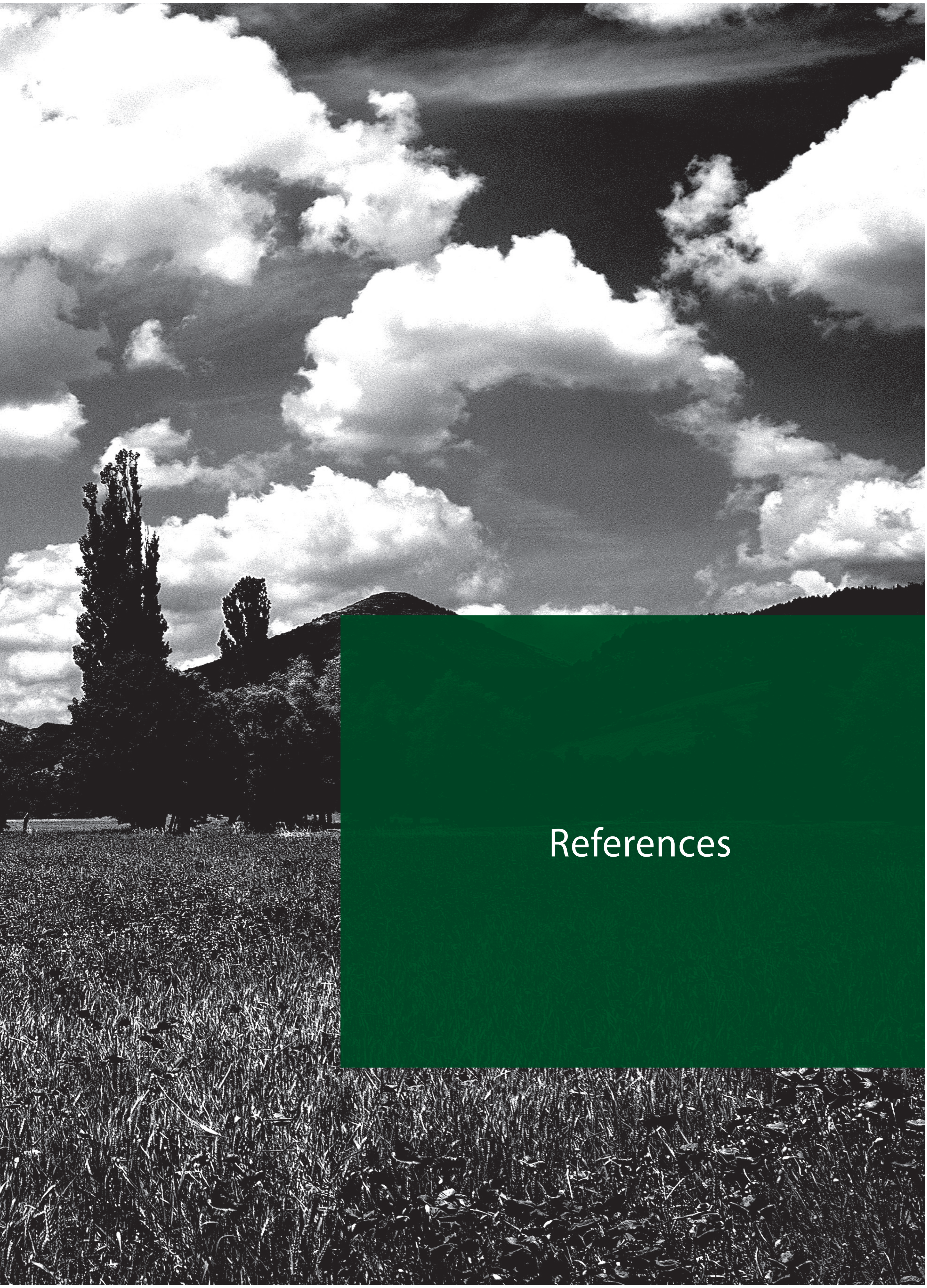
Table A5 shows the behaviour of deteriorator stocks (stocks with worsening climate metrics) and improver stocks (stocks with improving climate metrics) in our stylised strategies.

Table A5: Behaviour of deteriorator and improver stocks

	Type T1	Type O1	Type T2	Type O2
Average deteriorator weights in portfolio	18.16%	18.49%	17.34%	17.38%
Percentage of deteriorators with increased weight	33.5%	36.5%	40.9%	29.2%
Average deteriorator stock weight	0.052%	0.053%	0.049%	0.050%
Average absolute increase in weight of deteriorators when their weight has increased from the previous period	0.011%	0.019%	0.015%	0.032%
Average improver weights in portfolio	18.94%	19.15%	19.02%	19.17%
Percentage of improvers with increased weight	58.6%	51.3%	57.2%	37.8%
Average improver stock weight	0.061%	0.062%	0.062%	0.062%
Average absolute increase in weight of improvers when their weight has increased from the previous period	0.014%	0.024%	0.020%	0.038%

We report results for each strategy type, averaging across the 8 different climate scores we maintain. Our results thus provide a complete picture across these climate metrics. We note that results align very closely across all metrics so that averaging does not hide relevant information. We assess measures once a year in June from 2011 to 2020 and report the average value. Each strategy is assessed on the specific carbon metric used in the score tilting or optimisation to ensure they have improved in 'greenness' at the portfolio level.

18 - We use the Scientific Beta basic geographical blocks within the Developed universe: US, Canada, Eurozone, UK, Developed Europe ex Euro/UK, Japan and Developed Asia-Pacific ex-Japan.



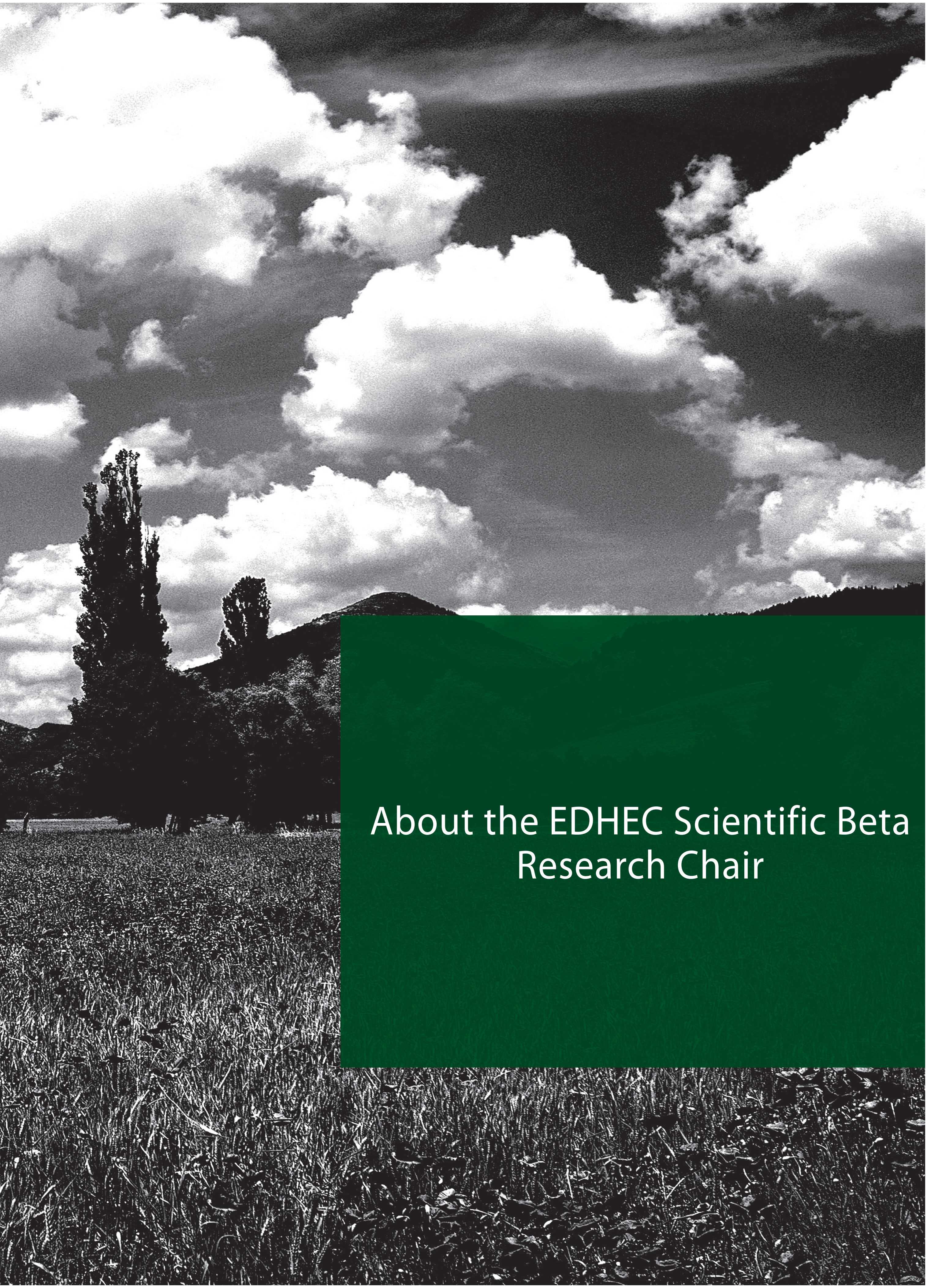
References

References

- Amenc, N. and F. Ducoulombier (2020). Unsustainable Proposals – A critical appraisal of the TEG Final Report on climate benchmarks and benchmarks' ESG disclosures and remedial proposals. Scientific Beta White Paper, February.
- Andersson, M., P. Bolton and F. Samama (2016). Hedging Climate Risk. *Financial Analysts Journal* 72(3) 13-32.
- Andreoni, J. (1989). Giving with Impure Altruism: Applications to Charity and Ricardian Equivalence, *Journal of Political Economy* 97(6) 1447-1458.
- Bolton, P. and M. Kacperczyk (2021). Do Investors Care about Carbon Risk? *Journal of Financial Economics*. Forthcoming.
- Brest, P.A., R.J. Gilson and M.A. Wolfson (2019) How Investors Can (and Can't) Create Social Value. *Journal of Corporation Law* 44 205.
- Brinson, G. P., L.R. Hood and G.L. Beebower (1986). Determinants of Portfolio Performance. *Financial Analysts Journal* 42(4) 39-44.
- Busch, T., M. Johnson, T. Pioch and M. Kopp (2020) Corporate carbon performance data: Quo vadis? *Journal of Industrial Ecology* 1– 14.
- Cochrane, J. (2021) The price of indulgences. Blogpost available at https://johnhcochrane.blogspot.com/2021/05/the-price-of-indulgences-2021.html.
- Cohen, L., U.G. Gurun and Q. Nguyen (2020). The ESG - Innovation Disconnect: Evidence from Green Patenting. European Corporate Governance Institute – Finance Working Paper No. 744/2021.
- Dawkins, C.E. (2018). Elevating the Role of Divestment in Socially Responsible Investing. *Journal of Business Ethics* 153 465–478.
- Ducoulombier, F. (2021) Understanding the Importance of Scope 3 Emissions and the Implications of Data Limitations, *Journal of Impact and ESG Investing* 1(4) 63-71.
- Ducoulombier, F. and V. Liu (2021). Carbon Intensity Bumps on the Way to Net Zero. *Journal of Impact and ESG Investing* 1(3) 59-73.
- Green, D. and B. Roth (2020). The Allocation of Socially Responsible Capital. Working Paper.
- Heinkel, R., A. Kraus and J. Zechner (2001). The effect of green investment on corporate behavior, *Journal of Financial and Quantitative Analysis* 36(4).
- IIGCC (2021). Net-Zero Investment Framework Implementation Guide. Available at https://www.iigcc.org/download/net-zero-investment-framework-implementation-guide/?wpdmdl=4425).
- IPCC (2018). Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Available at https://www.ipcc.ch/sr15/.
- Hong, H.G., N. Wang and J. Yang (2021). Welfare Consequences of Sustainable Finance. Available at SSRN: https://ssrn.com/abstract=3805189.
- Landier, A. and S. Lovo (2021). ESG Investing: How to Optimize Impact? Working Paper.
- Merton, R. (1969) Lifetime Portfolio Selection under Uncertainty: The Continuous-Time Case. *Review of Economics and Statistics* 51(3) 247–257.
- Nordhaus, W. (2019). Climate Change: The Ultimate Challenge for Economics. *American Economic Review* 109(6) 1991-2014.

References

- Oehmke, M. and M.M. Opp. (2020) A Theory of Socially Responsible Investment. Working Paper.
- Rohleder, M., M. Wilkens and J. Zink (2021) The Effects of Mutual Fund Decarbonization on Stock Prices and Carbon Emissions. Available at SSRN: https://ssrn.com/abstract=3612630.
- Sharpe, W.F. (1992) Asset Allocation: Management Style and Performance Measurement. *Journal of Portfolio Management* Winter 7-19.



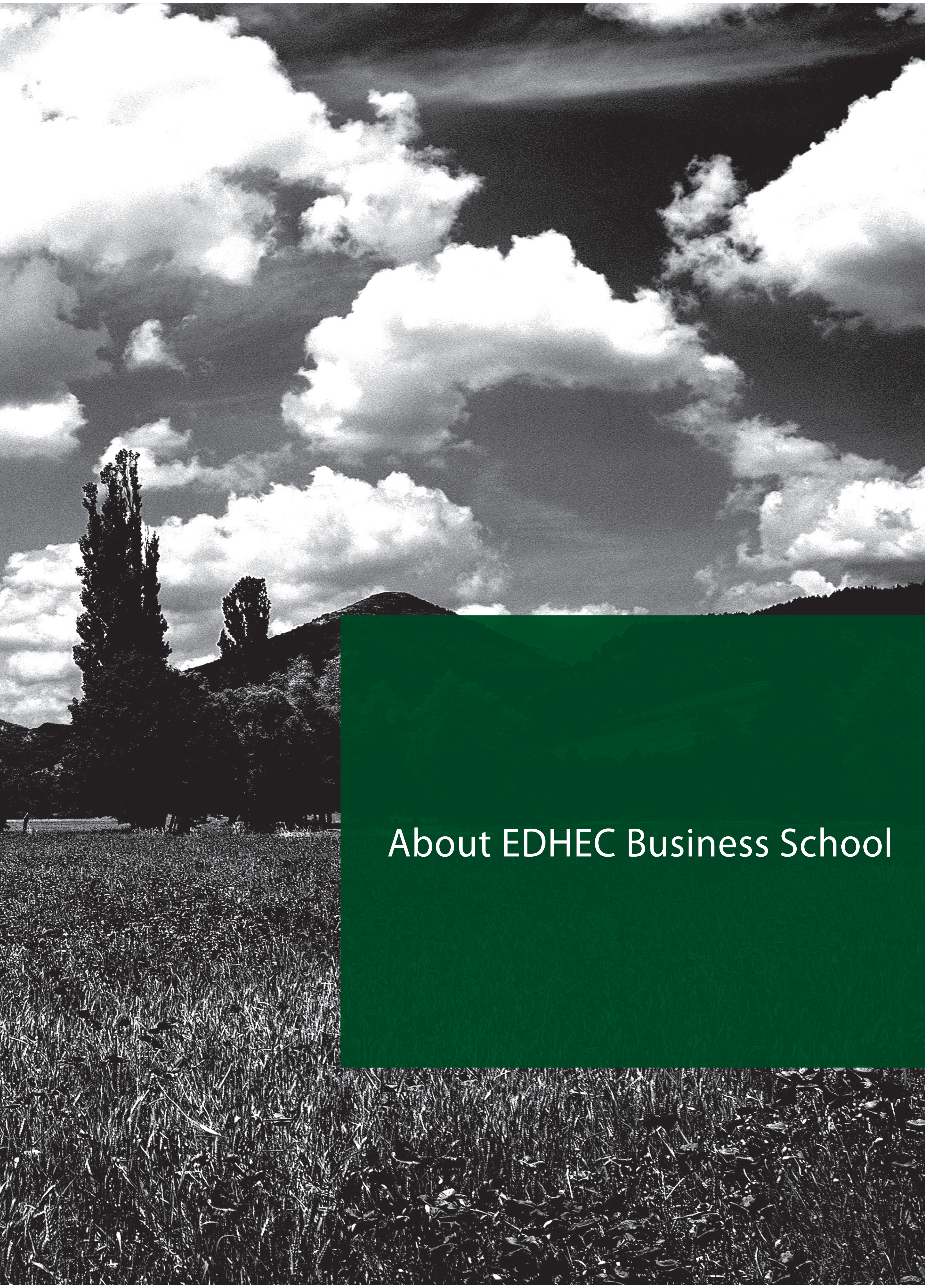
About the EDHEC Scientific Beta Research Chair

About the EDHEC Scientific Beta Research Chair

In 2012, EDHEC set up Scientific Beta, a "smart beta" index provider, on the strength of EDHEC-Risk Institute's research on the quantitative management of equity portfolios. The quality of the research and the intellectual leadership of its team enabled Scientific Beta to rapidly become one of the leaders in the new forms of systematic management of equities, with a total of more than USD 60 billion in assets under replication and institutional clients not only in Europe but also in North America and Asia.

Sold to the Singapore Stock Exchange for over EUR 200 million at the beginning of 2020, Scientific Beta continues to cooperate with EDHEC, especially by participating in joint research projects and by co-financing a research chair on ESG and climate investing. This research chair, endowed with an annual budget of EUR 1 million, contributes to improving knowledge and supporting research into integrating ESG and climate dimensions into institutional investors' investment processes, risk management and asset allocation.

This chair, together with the research conducted by EDHEC-Risk Institute in the area of climate investing, prefigures the creation of a new institute, the EDHEC-Risk Climate Impact Institute (ERCII), which will be officially launched at the end of 2021.



About EDHEC Business School

About EDHEC Business School

Founded in 1906, EDHEC is now one of Europe's top 15 business schools. Based in Lille, Nice, Paris, London and Singapore, and counting over 90 nationalities on its campuses, EDHEC is a fully international school directly connected to the business world. With over 40,000 graduates in 120 countries, it trains committed managers capable of dealing with the challenges of a fast-evolving world. Harnessing its core values of excellence, innovation and entrepreneurial spirit, EDHEC has developed a strategic model founded on research of true practical use to society, businesses and students, and which is particularly evident in the work of EDHEC-Risk Institute and Scientific Beta. The School functions as a genuine laboratory of ideas and plays a pioneering role in the field of digital education via EDHEC Online, the first fully online degree-level training platform. These various components make EDHEC a centre of knowledge, experience and diversity, geared to preparing new generations of managers to excel in a world subject to transformational change.

EDHEC in figures: 8,600 students in academic education, 19 degree programmes ranging from bachelor to PhD level, 184 professors and researchers, 11 specialist research centres.

For more information: www.edhec.edu


EDHEC
BUSINESS SCHOOL