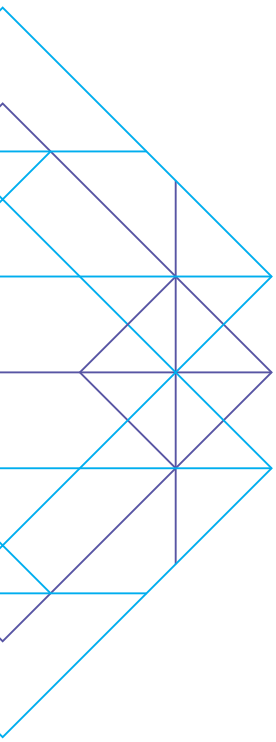


Alternative Thinking | 4Q19

Responsible Asset Selection: ESG in Portfolio Decisions

PSG
Portfolio Solutions Group

Executive Summary

- Environmental, Social, and Governance (ESG) considerations are an increasingly important input in investors' portfolio decisions. We discuss how these considerations may be incorporated in a portfolio and how they may affect risk and return outcomes.
- ESG is a broad term that many investors may define differently. Thus, we begin by outlining a framework designed to clarify how ESG may enter an investment process.
- We focus here on security selection, highlighting the distinction between using ESG signals to enhance the investment view of a security's risk or return potential and incorporating explicit non-investment objectives into a portfolio.
- Finally, we leverage a recently developed ESG-efficient frontier framework to show how ESG integration and screening lend themselves to a quantitative investment process and to quantify their expected impact on performance in several practical applications.

Contents

Introduction

The allure of "doing well by doing good" continues to absorb the investment industry. Responsible or ESG investing[1] is moving fast and growing rapidly. Billions of dollars are flowing to ESG strategies around the globe. Institutions and policymakers are frequently debating ESG issues. Executives such as the nearly 200 CEO members of the Business Roundtable are changing, at least, the language they use when describing their companies, advocating a framework to maximize all stakeholder value, not merely shareholder value.[2]

We seek to offer a balanced perspective on some of the foundational questions surrounding ESG investing. There is understandably a lot of promise and excitement around this topic, and the advent of new data and challenging problems (e.g., how to measure a portfolio's climate exposure) will keep researchers and portfolio managers busy for the foreseeable future. At the same time, as with all new fields, there is some hype. ESG is not a cure-all for portfolio managers or for their clients, and neither is it an arbitrage opportunity that may confer a non-financial benefit for the portfolio in all instances (e.g., promoting socially responsible businesses) with no associated investment cost. As in all of economics, trade-offs abound, and one of the goals of this piece is to explain where such trade-offs have the potential to improve expected returns and where they might present challenges.

1 We use "ESG" and "Responsible Investing" interchangeably throughout this paper.
2 "Statement on the Purpose of a Corporation," Business Roundtable, August 2019.

What is ESG?

"ESG," short for Environmental, Social, and Governance, is a broad umbrella term that people might interpret very differently. In the investing context, ESG spans the gamut from incorporating non-financial data to improve one's investment view, to working with norms-based screens (e.g., no tobacco), to thematic portfolio goals (e.g., reduction in carbon exposure), to impact investing (e.g., investing with the goal of achieving a concrete social or environmental objective). This vast scope makes it difficult for stakeholders to communicate with one another. It also contributes to the lack of agreement on some of the most fundamental questions, for example, whether ESG helps or hurts investment performance.

So, we start by setting the terms, leveraging the framework established by AQR colleagues in collaboration with the United Nations Principles for Responsible Investment (UN PRI).[3]

Exhibit 1
ESG framework based on "Clearing the Air" by Dunn, Hernandez, and Palazzolo (2019)

Responsible Asset Selection					+	Responsible Ownership			
Screening			ESG Integration			Voting	Engagement	Activism	Direct Management
Norms-Based (static)	**ESG** (dynamic)	**Thematic**	**Valuation**	**Risk**		e.g.:	e.g.:	e.g.:	e.g.:
e.g.: - Coal - Tobacco	- Environmental - Social - Governance	e.g.: - Green - Impact	- Environmental - Social - Governance	- Environmental - Social - Governance		- ESG-focused - ESG-aware	- Campaign - Disclose	- Board seat - Acquire shares	- Private equity - Other illiquids

Source: AQR, UN PRI. Framework for illustrative purposes only. The framework is designed to allow for the application of a multitude of approaches.

Exhibit 1 illustrates the Responsible Investment framework that comprises both Responsible Asset Selection and Responsible Ownership. Many investors concerned with ESG have focused on removing controversial stocks or industries from their investment universe. Increasingly, such investors also consider *ESG integration* and look at ESG factors as one input in an overall evaluation of an investment, whether from a risk or return perspective. Responsible Ownership — what you do after making an investment — is also important. Equity investors can express their opinions in shareholder votes, directly or using proxy voting services, and may pursue more active methods of engagement such as acquiring a seat on the board of directors. In this article we focus on Responsible Asset Selection only and ask how ESG considerations may affect the choice of securities in an investor's portfolio. We save the important discussion of Responsible Ownership for a future edition of *Alternative Thinking*.

3 See Dunn, Hernandez, and Palazzolo (2019).

Does ESG help investment performance?

Perhaps the most frequently asked question about ESG is whether it helps investment performance. This question is difficult to answer as posed: as we saw in the prior section, "ESG" can mean many things.

If ESG is meant as an additional source of data that informs an investment view, then the answer is a qualified "yes." Of course, we do not suggest that any and all ESG data may increase expected returns; rather, a manager's research team may be able to isolate precious ingredients of ESG that are material and not (yet) fully priced by the market. This may be true only for a small fraction of what ESG covers, if for no other reason than investors are actively looking for it and markets are competitive. Our next section shows economic intuition and empirical evidence suggesting that *some* dimensions of ESG may improve expected returns, with examples in public equities, corporate credit, and sovereign fixed income.

The relationship between ESG and risk is easier to demonstrate, and it may span a broader range of ESG-type metrics. We discussed this in a recent white paper, "Assessing Risk through Environmental, Social, and Governance Exposures" (Dunn, Fitzgibbons, and Pomorski, 2017).[4] In that paper we show that stocks with attractive ESG characteristics tend to be less risky and of higher quality. In addition to this contemporaneous correlation, there is also some evidence of predictability: strong ESG characteristics today correlate with lower statistical risks as much as five years out. Not surprisingly, some managers choose to incorporate ESG into their risk models and processes. While Dunn et al. (2017) focused on public equities, this insight may apply to other asset classes; for example, macro-level ESG data is a sub-component of AQR's country and currency crisis risk model.

However, if ESG is meant as an objective that supersedes investment return objectives for the investor,[5] then the answer to whether it helps returns becomes a qualified "no." Of course, a portfolio that incorporates non-financial goals may still be very attractive and well positioned to outperform its benchmark. However, it should be expected to do worse than an otherwise similar portfolio run without non-financial ESG objectives.[6] To illustrate this, consider an investor who wants her portfolio to have a 50 percent lower carbon intensity score than the benchmark. A manager with no constraints could synthesize all available data and create a portfolio that she thinks has the highest financial return for her client. A manager with a dual

4 The insight that ESG overlaps with risk is not unique to AQR: the connection between ESG and risk has been documented, for example, in Ilhan, Sautner, and Vilkov (2018) or Hoepner et al. (2018), just to cite two recent studies. Neither is it unique to equities, with macro risk models potentially benefiting from inclusion of political risk factors (the macro equivalent of "governance"), etc.

5 This objective is increasingly prevalent; as just one example, a number of the world's largest institutions recently signed a United Nations agreement to transition investment portfolios to net-zero greenhouse gas emissions by 2050, see: https://www.unepfi.org/net-zero-alliance/.

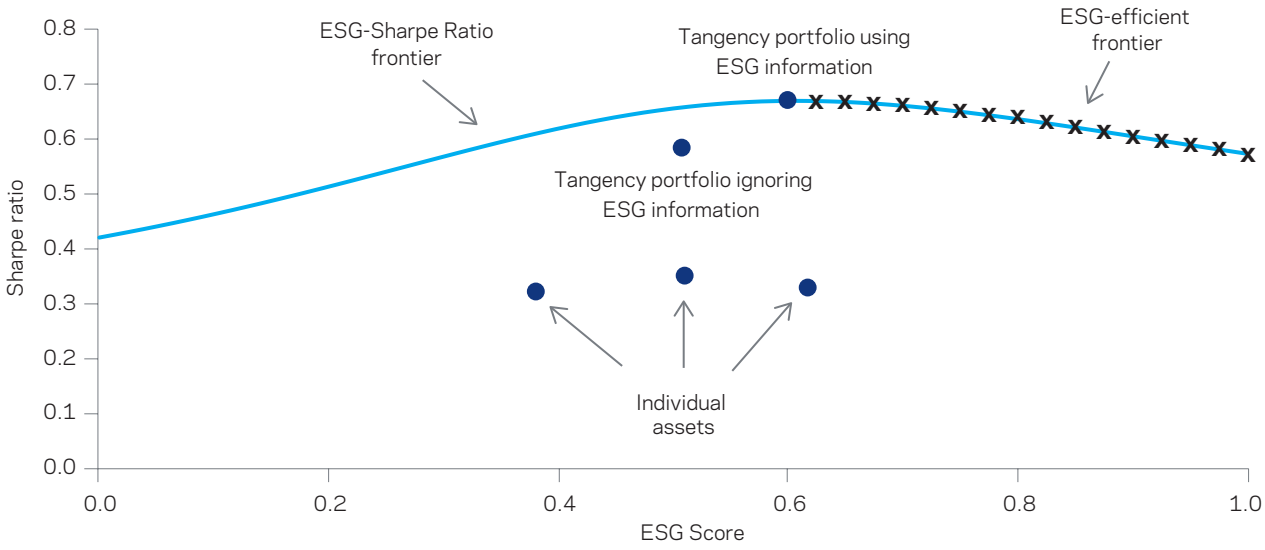
6 Constraints of any kind, including ESG ones, can never help you ex ante although they might fortuitously help you ex post (e.g., the excluded companies might go bankrupt). See Asness, 2017, "Virtue Is Its Own Reward or One Man's Ceiling Is Another Man's Floor."

objective (50 percent carbon reduction and financial returns) might not have to change the portfolio, but more likely than not, she would need to adjust the optimal portfolio to accommodate this dual objective.[7]

To formalize the pro and con arguments, Pedersen, Fitzgibbons, and Pomorski (2019) built the concept of an "ESG-Sharpe Ratio frontier" that summarizes the trade-offs between ESG and performance. The frontier shows, for each possible level of ESG score, the portfolio that maximizes the Sharpe ratio while at the same time satisfying that level of ESG score. An example of such a frontier is shown in *Exhibit 2*. The frontier is hump-shaped, with the maximum corresponding to the classic tangency portfolio, or the optimal portfolio for a mean-variance investor who is ESG-agnostic (i.e., who will simply accept the level of ESG that happens to correspond to the global maximum Sharpe ratio).

Exhibit 2

Stylized example of an ESG-Sharpe Ratio frontier.



Source: Pedersen, Fitzgibbons, and Pomorski (2019). For illustrative purposes only. Our illustration relies on a simple example with four assets that have zero correlation to one another and the following assumptions: expected returns of 5 percent, 10 percent, 15 percent, and 20 percent; expected variances of 0.0625, 0.0625, 0.25, and 0.25; and expected ESG scores of 0.1, 0.5, 0.4, and 0.2. We assume a normal distribution for each asset.

Investors who derive additional utility from ESG (for example, those with non-financial objectives) will optimally choose a portfolio to the right of that tangency portfolio. Such portfolios, forming the ESG-efficient frontier, trade off a reduction in the Sharpe ratio with an increase in their ESG profile. We stress that accepting such a reduction may not be an investment mistake. In the model, and hopefully in many real-world situations, investors are well aware of the trade-off and accept the reduction as the price for attaining multiple portfolio goals.

Finally, Exhibit 2 also shows the "tangency portfolio ignoring ESG information." If some aspects of ESG are helpful in investment analysis, then this portfolio will lie strictly below the ESG-SR frontier. In other words, for any desired level of ESG, adding ESG information to one's process can lead to portfolios with a higher Sharpe ratio. If ESG information is not relevant for risk or returns, the two tangency portfolios (with and without ESG information) will coincide. The next section shows sample studies in which ESG information may have improved risk-adjusted returns.

7 Equilibrium theory also suggests an indirect channel: if enough ESG-sensitive investors shun a company, the current price of the company drops and future expected returns increase. (The extra returns may be interpreted as a compensation for those remaining investors who agree to bear the displeasure of owning this company.) If the return differential becomes large, this may be an additional headwind when investors restricting this stock are compared to an index that includes it. For discussions of such a "sin premium," please see Hong and Kacperczyk (2009) or Asness (2017). An exhaustive model would also include a possibility of a repricing effect: as tastes change, sin stocks lose some investors and market value (indeed, it is this repricing that subsequently leads to a "sin premium"). It has been suggested that such a repricing may be affecting tobacco or carbon-emitting firms, temporarily overwhelming a long-run sin premium. Clearly, the issue is complex, and the debate is likely to go on.

ESG data challenges: Can non-financial ESG information be quantified?

All investors need data, and no manager has a crystal ball highlighting which stocks to buy or sell. When it comes to ESG, relevant information may come from a range of sources, including third-party ESG data vendors, signals derived from raw information in typical financial databases, in-person conversations, media sources, web scraping, etc.

As an example, consider a Governance signal (the "G" in ESG) based on the importance of accruals in a firm's profits. When profits are derived mainly from cash, they tend to be more conservative; profits derived mainly from accruals may be less certain. Indeed, research shows that companies subject to SEC enforcement actions tend to have abnormally high accruals prior to such actions (e.g., Richardson, Sloan, Soliman, and Tuna, 2006). Heavy accruals users also have historically had a higher likelihood of earnings restatements (e.g., Richardson, Tuna, and Wu, 2002). Such evidence makes a compelling argument that the metric indeed captures some Governance information and doesn't merely indirectly correlate with ESG.

Could accruals be one of the ESG signals that help improve expected returns? *Exhibit 3* shows that accruals scaled by assets may be helpful in forecasting equity returns (Panel A), as suggested by Sloan (1996) and several subsequent papers.

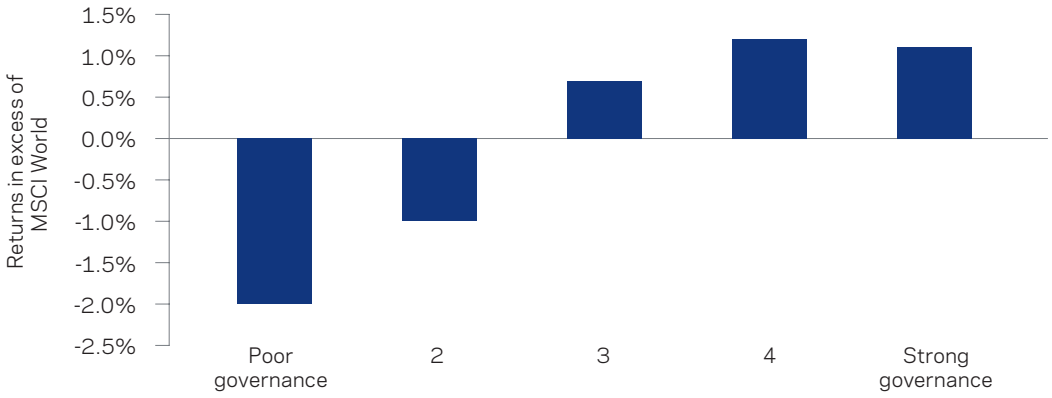
The same metric, applied at the issuer level, may forecast corporate bond returns. In Panel B we look at Global Investment-Grade bonds, which is a roughly equivalent universe of companies as in Panel A (large-cap developed markets companies in the MSCI World index). Here we plot credit returns, meaning corporate bond returns in excess of duration-matched Treasuries. Not surprisingly, corporate bonds on average outperform Treasuries (all bars are positive), but bonds from better-governed issuers have generated higher returns.

The same general idea (good Governance makes a security attractive) may also translate to other asset classes, for example sovereign fixed income. Panel C suggests that bonds issued by better-governed states, or at least states with better-governed central banks, may be more attractive investments. For this exhibit, we look to where governance may be particularly important: emerging market debt. For a simple illustrative metric of governance, we use expected inflation, based on the idea that countries with less credible/less independent central banks have worse Governance, and as a result may also have relatively higher rates of expected inflation.

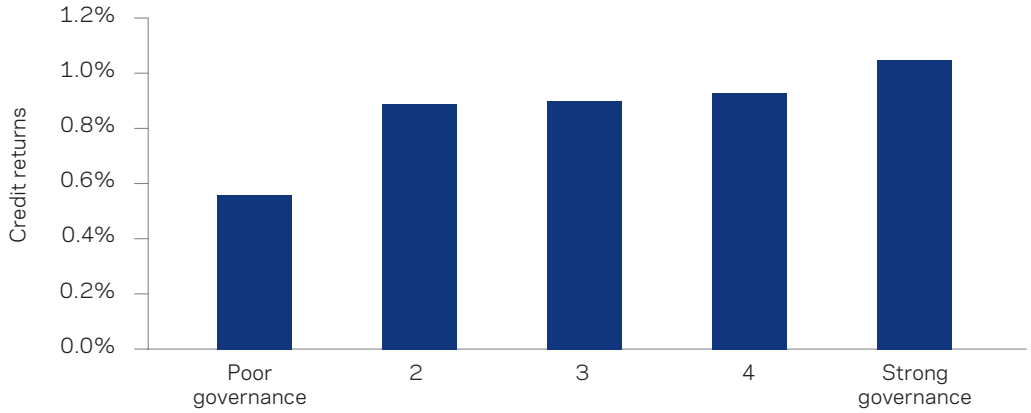
Exhibit 3

Governance is positively related to excess returns in various hypothetical asset class returns

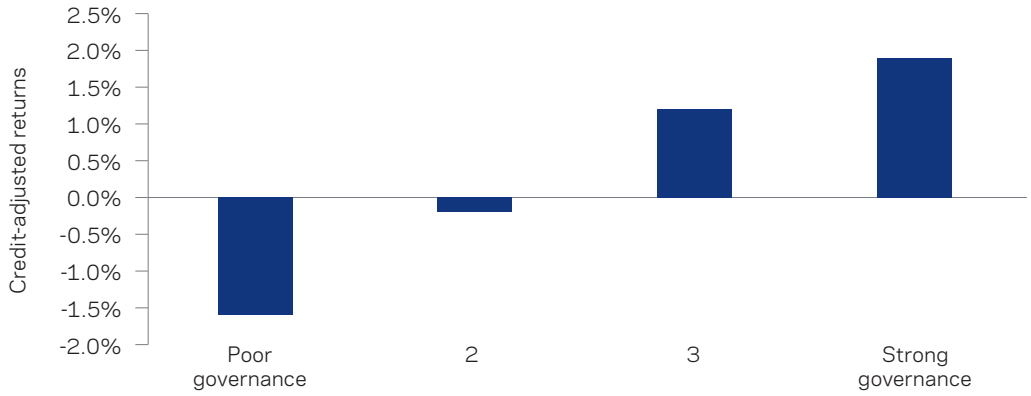
Panel A: Application to public equities



Panel B: Application to corporate bonds



Panel C: Application to sovereign bonds



Sources: AQR, MSCI, Bank of America Merrill Lynch, JPMorgan, Consensus Economics. For illustrative purposes only and not related to any portfolio that AQR currently manages. Returns are gross of fees and transaction costs. Backtest construction methodologies and data are in the appendix. Hypothetical data has inherent limitations, some of which are disclosed in the appendix.

The signals highlighted above have good and consistent data coverage, but not all ESG signals have this property. As of this writing, there are no clear industry standards to guide what companies report, what data is gathered, or how it is aggregated.[8] Consequently, ESG data may suffer from a variety of weaknesses or outright biases such as:

- In many cases the history of data is short — perhaps only a decade.
- Cross-sectional coverage is low — some data is only available for specific industries or regions.
- Some data providers backfill or correct data, making it difficult to know what would have been available at each point in time.
- Some data is self-reported via surveys, leading to greenwashing or creative reporting.
- Selection biases, such as searching for positive relations, can happen also in ESG research.

Some managers may decide to leverage data obtained from dedicated third-party ESG data providers, if only because of the transparency such data offers (which could make it particularly useful for reporting). A common complaint about such data is that it is weakly correlated across providers, with examples of historical pairwise correlations between 0.3 and 0.8.[9] We might expect Governance metrics to be among the most correlated because they are arguably more straightforward to measure than say Social exposures and are backed by well-known academic research (e.g., Gompers, Ishii, and Metrick, 2001). In practice, however, the Governance pillar has historically been the least correlated across providers.[10]

At the same time, it is comforting that the correlations clearly are positive. This suggests that the various data providers, with their often very different processes, are all approximating some core ESG characteristics of a company. Some noise is to be expected, not just for ESG but also for other investment themes.

Finally, the low correlations may indicate the divergence of opinions about ESG across market participants. This opens up an exciting opportunity for active managers. Being able to identify good or bad ESG companies more precisely or earlier than other investors may lead to an investment edge. As the market converges to perfect agreement on what "true" ESG is, this edge would perhaps dull and disappear; share prices would also adjust. We take no stand on whether this would be a positive or negative development; we just note that this may lead to meaningfully different market dynamics from what we observe today.

8 This is a dynamically changing area, and there are efforts by Sustainability Accounting Standards Board (SASB), European regulators, etc., to come up with frameworks, reporting requirements, etc.

9 Bender et al. (2018). In another paper, Berg et al. (2019) report correlations of 0.4 to 0.7 between five prominent rating agencies.

10 Brandon et al. (2019) find the lowest average correlations for Governance in a sample of S&P 500 firms between 2013 and 2017 of 0.2 vs 0.4 and 0.3 for Environmental and Social data providers respectively. Barclays (2018) find similarly for the US and European corporate index universes between 2009 and 2018.

ESG implementation with non-financial goals: screening

There are two primary ways in which an investor could address a non-financial goal in their portfolio: screening and tilting.

Screening is the oldest, arguably the most direct, and still a popular way to incorporate non-financial ESG goals into asset selection.[11] It restricts the investment universe, whether by removing securities with the worst ESG characteristics (negative screening) or by focusing the universe on high ESG securities only (positive screening, often referred to as "best in class"). An indirect form of screening may be through the choice of a narrow ESG-oriented benchmark and perhaps constraining off-benchmark holdings.

A clear advantage of screening is that it directly restricts those stocks with a particularly poor ESG profile from being held. This might be important for investors with strong ethical views, for whom screening is the only way to ensure that "sin" stocks are avoided. A disadvantage is that screens by definition reduce the breadth of the investment universe. This makes screening a poor option when the restriction is very broad. For example, a climate-aware investor may want to reduce the emissions footprint of their portfolio. A screen may not be a good practical solution because it is not clear how many stocks to restrict (most companies produce at least some emissions) because it would be highly concentrated (disproportionally affecting a few industries such as Utilities, Materials, and Energy) but also because a screen may not guarantee that the overall portfolio emits less than the benchmark.[12] In such a situation, tilting through a portfolio-level constraint may be a better idea.

11 FTSE Russell, "Smart Sustainability: 2019 global survey findings from asset owners."
12 For example, a portfolio that screens out 10 percent of the largest polluters but then meaningfully overweights the next 10 percent might end up with a higher emissions intensity than the overall benchmark.

Screening case study: Hit 'em where it hurts?

Screening may be a long-standing concept, but even here we see interesting innovations. For example, shorting will cause many investors to rethink their norms-based restrictions. A restriction such as "no fossil fuels" is straightforward in the long-only context, but no longer obvious for an equity market neutral or even for a "Relaxed Constraint"[13] portfolio. It may be clear that the manager will not allow exposure to fossil fuels in the long leg of the portfolio, but there are good reasons they might consider shorting such stocks. For example, shorts may be attractive precisely because of the ESG views integrated into the manager's process. Data providers and portfolio managers speaking at conferences often give "negative" examples of how ESG drives investment ideas: a polluting company that gets into trouble with the regulators; a firm that does not care for its employees and consequently faces a consumer backlash; or a poorly governed company that becomes involved in a scandal. These are great examples, and they clearly resonate with investors. We note that a more forceful way to incorporate such ideas into a portfolio is through short selling, rather than simply screening out such companies.[14]

Moreover, traditional restrictions lead to a dilemma: on the one hand, investors may be displeased with a company; on the other, they would like to see that company change. Unfortunately, not holding the company is a poor way to seek impact.[15] Investors who abstain from holding do not get a vote and will likely find it difficult to engage with corporate management. Remarkably, something changes when non-holders become short-sellers. They still don't get a vote, but company executives have become increasingly aware of what the short community says. Of course, the relationship with the short community is sometimes hostile (examples abound in financial media), but this at least suggests that the shorts have a more direct communication channel to the management than non-holders.[16]

13 Also popularly known as 130/30 strategies. "Relaxed Constraint" portfolios are benchmark-relative strategies that allow a predetermined fraction of shorts.
14 In a long-only portfolio, screening is equivalent to a "maximum allowable short position," with an explicit short active positioning versus the cap-weighted benchmark. Indeed, if the restricted stocks underperform, the screen might generate excess returns versus the benchmark. For illustrative purposes only.
15 For example, "Divestment Does Nothing to Halt Climate Change, Bill Gates Says," *Financial Times, September 18, 2019.*
16 We expand on these ideas in a short note, "ESG 2.0: Hit 'em where it hurts," Fitzgibbons, Palazzolo, and Pomorski (2018).

ESG implementation with non-financial goals: tilting

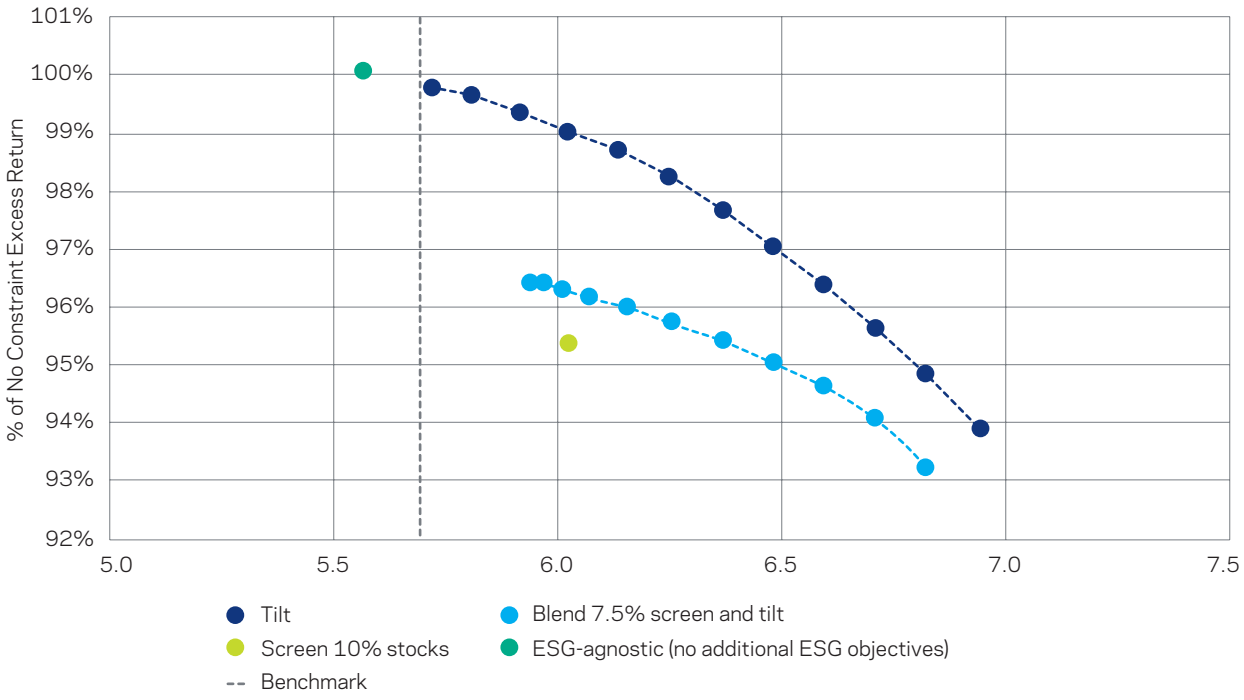
A second broad way to incorporate non-financial goals is through tilting. This can be achieved by building an ESG investment factor and thus changing the weight of each stock in the portfolio as a function of that stock's ESG profile. Another possibility is tilting by imposing portfolio-level ESG constraints and thus allowing an optimizer to select the specific stocks to over- or under-weight so that the overall portfolio has a higher ESG score than its benchmark.

An advantage of tilting is that it may lead to a more efficient implementation than a screen — in other words, achieving the ESG goal with less investment distortion. An example of this, mentioned above and studied in more detail in the next section, is reducing the portfolio-level carbon footprint. A disadvantage is that unlike screening, the resulting portfolio may still hold securities with very unattractive ESG profiles. For example, the investment process may tilt away from a poor ESG security, but if that security is attractive on other investment dimensions (e.g., cheap and improving), it might still be held in the portfolio. For this reason, some investors may find it useful to combine tilting with some screening to at least avoid holding the very worst offenders.

We illustrate the trade-off between screening and tilting in *Exhibit 4*. We plot a version of the ESG-efficient frontier from Exhibit 2, with the "ESG score" reflecting a portfolio's score using stock-level MSCI ESG data. On the y-axis, performance is measured as a fraction of alpha of the "ESG-agnostic" portfolio, with no ESG-type constraints. In our illustration, this ESG-agnostic portfolio happens to have the ESG score of 5.5, slightly lower than the cap-weighted benchmark. The "tilting" frontier is built by requiring that the portfolio has increasingly better ESG score: for example, requiring the ESG score of 6 reduces expected performance by about 1 percent (i.e., the best portfolio with the ESG score of 6 recovers about 99 percent of the "ESG-agnostic" alpha). In comparison, a simple screen that removes the 10 percent of stocks with the worst ESG profile also leads to the ESG score of about 6, but at a higher investment cost (it recovers about 95% of the "ESG-agnostic" alpha). Finally, Exhibit 4 also shows a blend of a tilt and a (less restrictive) screen of 7.5 percent instead of 10 percent.

Exhibit 4

Comparing tilting and screening via a hypothetical ESG-efficient frontier



Sources: AQR and MSCI. Notes: The figure shows portfolio ESG score on the horizontal axis and expected (ex ante) returns on the vertical axis, as a fraction of the expected returns of ESG-agnostic portfolio (i.e., the portfolio with no ESG constraints). For illustrative purposes only. There is no guarantee that this strategy will be successful. There is a potential for loss. Backtest construction methodologies and data are in the appendix. Returns are gross of fees and transaction costs. Hypothetical data has inherent limitations, some of which are disclosed in the appendix.

Tilting case study: Climate-aware portfolios

Climate change is at the forefront of public discourse. Investors ask what exposure their portfolios have to climate change, whether as a risk management concern, as an investment thesis, or to increase their portfolios' impact. Here, we apply the concepts we discussed above to a specific climate-related solution: managing a portfolio's carbon intensity, measured as the portfolio companies' ratio of CO_2-equivalent emissions in tons to revenue in millions of dollars. This measure is simple to define, uses relatively well-known data sources, and allows for easily quantifiable goals (for example, reducing carbon intensity by at least 25 percent versus the cap-weighted benchmark).[17] Moreover, while our example is specific to listed equities, the same concepts translate into credit but potentially also to private assets or even to macro asset selection (e.g., estimating a whole country's carbon footprint).

17 Managing carbon emissions is by no means the only climate-related solution. Others may include constraining exposure to carbon reserves (which are at risk of becoming stranded assets), identifying stocks with potential green revenues, etc. Even the metric we focus on (carbon intensity, measured using scope 1+2 emissions) is not necessarily obvious: some investors may opt to use carbon ownership instead, ambitiously try to use scope 3 emissions, etc.

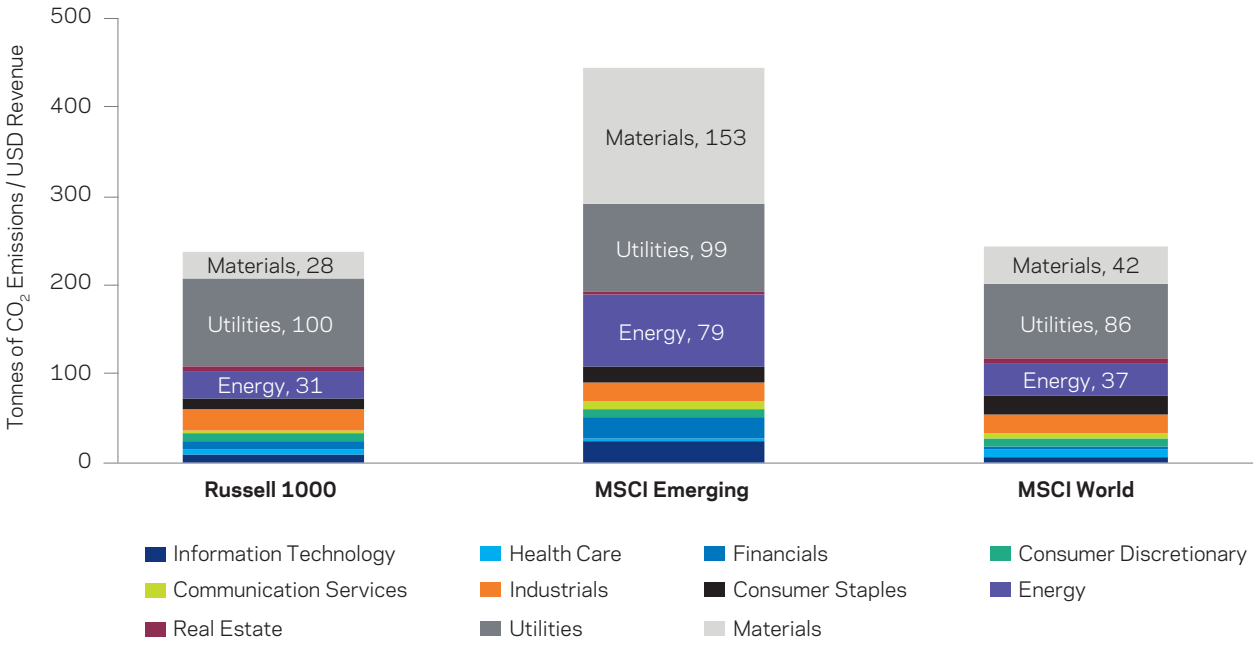
Simple screening and its consequences

Exhibit 5 shows that carbon emissions are highly concentrated in just a few sectors: Utilities, Materials, and Energy. This suggests a very simple way to reduce a portfolio's carbon footprint: simply exclude the three sectors above. For most investment processes, this should be enough to achieve a dramatic reduction in carbon emissions relative to a cap-weighted index that includes the three sectors. The downside is that the restriction removes a sizable portion of the investible universe; for example, as of April 30, 2019, Utilities, Materials, and Energy account for over 13 percent of the MSCI World index; the resulting impact on the tracking error could be even greater. Of course, one may choose not to remove all stocks in these three sectors and instead restrict only those that have particularly high emissions. This mitigates but does not fix the problem.

Exhibit 5

Sector-level carbon intensity

Carbon Intensity Score by Sector by Universe



Sources: AQR, MSCI, Russell, and Trucost. We are showing all GICS sectors as defined by MSCI. We multiply the market cap weight of each stock in each index (Russell 1000, MSCI Emerging, and MSCI World) and the Trucost carbon intensity score of each stock and sum the results by sector. Data as of August 31, 2019.

Integrating the screen with the investment view

Fortunately, carbon intensity can be incorporated into portfolio construction in a more nuanced manner. Low-carbon managers will, of course, tend to avoid carbon-intense stocks, but the specific stocks they avoid could depend on their investment view.

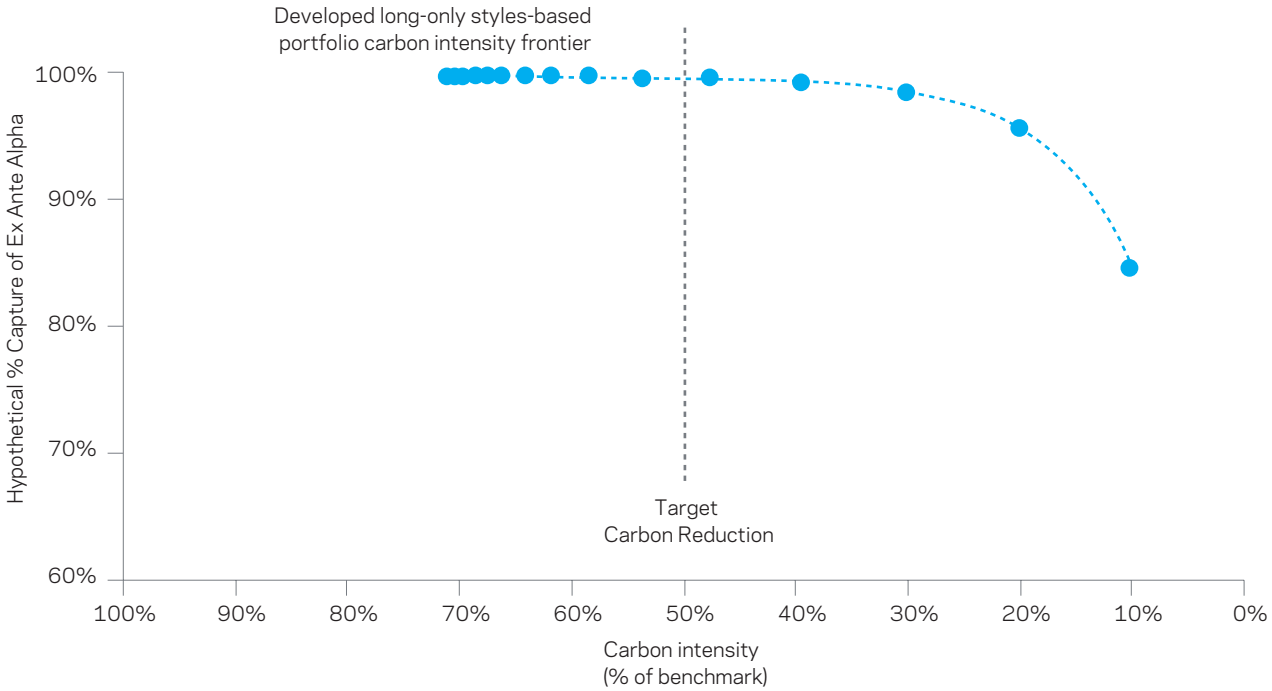
Exhibit 6 illustrates this by plotting the carbon version of the ESG-efficient frontier. The frontier is built by running a series of backtests that use the same investment universe and the same investment model and only differ in how much they constrain the carbon footprint of the portfolio. As in Exhibit 4, the y-axis shows performance as a fraction of the "carbon-agnostic" version of the portfolio.

The carbon objective and the investment view interact because at each point in time, the portfolio delivers its carbon goal by excluding those carbon-intense stocks with weaker tactical investment attractiveness. This approach makes carbon reduction relatively "cheap" (i.e., less distortive), even for a relatively large reduction in emissions. The constraint still binds, but at least initially the trade-off seems attractive; eventually, however, the constraint becomes quite onerous for very emissions-averse investors.

Exhibit 6

Hypothetical ESG-efficient frontier for carbon-aware portfolio[18]

Carbon Ownership vs. Hypothetical Expected Excess Return Of Low-Carbon Developed Long-Only Styles-Based Portfolio



Sources: AQR, MSCI, and Trucost. Notes: The figure shows portfolio carbon intensity on the horizontal axis and expected (ex ante) returns on the vertical axis, as a fraction of the expected returns of carbon-agnostic portfolio. For illustrative purposes only and not representative of an actual portfolio AQR manages. Backtest is gross of fees and gross of transaction costs. Please see appendix for backtest construction methodology and data. Hypothetical data has inherent limitations, some of which are disclosed in the appendix.

18 The carbon intensity score begins at 70 percent as the strategy we are using as a starting point, a long-only styles-based portfolio, generally underweights carbon intense sectors over this time period.

Is ESG compatible with quantitative investing?

One question we sometimes hear is whether ESG and systematic (quant) investing are compatible. Not surprisingly, as many examples above attest, our answer is "absolutely." We discussed in an earlier Alternative Thinking[19] how a systematic manager may capture soft information, and similar arguments apply to ESG. We are not suggesting that this is easy. A manager may need to conduct exhaustive research to overcome data issues and show considerable creativity to capture seemingly unquantifiable characteristics, for example lack of transparency, or strategic manipulation of information disclosed to shareholders, or empire building, or questionable accounting practices.

In fact, we think quantitative managers may have some advantages over discretionary investors. First, they may be better positioned to incorporate non-financial goals into their strategies and deliver such goals without jeopardizing the financial attractiveness of their process. Second, systematic managers may be more transparent to investors in that they can explicitly quantify the weight put on ESG signals or attribute performance to the ESG factors in their process. Finally, quant managers may be better equipped to calculate opportunity costs of ESG considerations as they can test alternative solutions or even run them as live "paper" portfolios, which may be more difficult for discretionary managers.

Of course, few tradeoffs in investments are completely one-sided, so there are areas where discretionary managers may have an advantage. For example, they may have a more in-depth view on any one company they invest in, and this holds also for ESG — they may have idiosyncratic ESG insights that some quants may miss.

19 See Alternative Thinking 3Q2017 "Systematic vs. Discretionary."

Conclusion

Investors and managers take varied approaches to ESG. No approach is necessarily right or wrong if it is communicated properly and if it is consistent with an investor's strategic objective. For some, portfolio objectives may extend beyond maximizing returns. Such non-financial goals may be driven by investor-specific ESG beliefs and constraints, which are constantly evolving.

For managers, being flexible and listening to clients is important, as is the craftsmanship in delivering investment solutions that meet their objectives. However, managers may not always rely on their clients to define "ESG" for them. This may not be possible for commingled portfolios, and even separate account owners may defer this difficult task to their managers. In either case, managers may need to specify *what* ESG information enters into their portfolio, perhaps explaining the intuition of why a given metric captures such information. They may also need to explain *why* it enters the portfolio and what the potential impact to the portfolio might be; we would suggest the "ESG-efficient frontier" may be a helpful framework for such conversations.

About the Portfolio Solutions Group

PSG provides thought leadership to the broader investment community and custom analyses to help AQR clients achieve better portfolio outcomes.

We thank Paras Bakrania, Lukasz Pomorski, and Alex Sanborn for their work on this paper. We also thank Jordan Brooks, Antti Ilmanen, Thomas Maloney, Toby Moskowitz, Chris Palazzolo, Lasse Pedersen, Scott Richardson, and Dan Villalon for their helpful comments and Ing-Chea Ang and Jatin Bhatia for their excellent research assistance.

References

Asness, 2017, "Virtue Is Its Own Reward or One Man's Ceiling Is Another Man's Floor," https://www.aqr.com/Insights/Perspectives/Virtue-is-its-Own-Reward-Or-One-Mans-Ceiling-is-Another-Mans-Floor.

AQR Alternative Thinking "Systematic vs. Discretionary." Third Quarter 2017.

AQR Curious Investor Podcast (2018), "ESG: The Good, the Bad, and the Fuzzy."

Barclays, 2018, "The case for sustainable bond investing strengthens," white paper.

Bender, Bridges, He, Lester, Sun, 2018, "A Blueprint for Integrating ESG into Equity Portfolio," *Journal of Investment Management*.

Berg, Florian; Kölbel, Julian; and Rigobon, Roberto; "Aggregate Confusion: The Divergence of ESG Ratings" (August 17, 2019). MIT Sloan Research Paper No. 5822-19.

Brandon, Krueger, Riand, and Schmidt, 2019, "ESG rating disagreement and stock returns," working paper, SSRN.

Dunn, Jeff; Shaun Fitzgibbons; and Lukasz Pomorski; 2018, "Assessing Risk through Environmental, Social, and Governance Exposures," *Journal of Investment Management*, Vol. 16, No 1.

Dunn, Hernandez, and Palazzolo, 2019, "Clearing the Air: Responsible Investment," AQR white paper.

Fitzgibbons, Shaun; Christopher Palazzolo; and Lukasz Pomorski, 2018, "ESG 2.0: Hit 'em Where It Hurts," IPE.

Gompers, Paul; Joy Ishii; and Andrew Metrick, 2003, "Corporate Governance and Equity Prices," *Quarterly Journal of Economics*, Vol. 118, Issue 1, 107–156.

Hoepner, Andreas G. F.; Ioannis Oikonomou; Zacharias Sautner; Laura T. Starks; and Xiaoyan Zhou, 2019, "ESG Shareholder Engagement and Downside Risk," working paper.

Hong, Harrison and Marcin Kacperczyk, 2009, "The Price of Sin: The Effects of Social Norms on Markets," *Journal of Financial Economics* 93 (1), 15–36.

Ilhan, Emirhan; Zacharias Sautner; and Grigory Vilkov, 2018, "Carbon Tail Risk," working paper.

Pedersen, Lasse Heje; Fitzgibbons, Shaun; and Pomorski, Lukasz; 2019, "Responsible Investing: The ESG-Efficient Frontier," working paper, SSRN.

Richardson, S. A., R. G. Sloan, M. T. Soliman, and I. Tuna, 2006, "The Implications of Accounting Distortions and Growth for Accruals and Profitability," Accounting Review, 81 (3), 713–743.

Richardson, S. A.; I. Tuna; and M. Wu; 2002, "Predicting Earnings Management: The Case of Earnings Restatements," working paper, University of Pennsylvania.

Disclosures/Appendix

This document has been provided to you solely for information purposes and does not constitute an offer or solicitation of an offer or any advice or recommendation to purchase any securities or other financial instruments and may not be construed as such. The factual information set forth herein has been obtained or derived from sources believed by the author and AQR Capital Management, LLC ("AQR"), to be reliable, but it is not necessarily all-inclusive and is not guaranteed as to its accuracy and is not to be regarded as a representation or warranty, express or implied, as to the information's accuracy or completeness, nor should the attached information serve as the basis of any investment decision. **This document is not to be reproduced or redistributed without the written consent of AQR.** The information set forth herein has been provided to you as secondary information and should not be the primary source for any investment or allocation decision.

Past performance is not a guarantee of future performance.

This presentation is not research and should not be treated as research. This presentation does not represent valuation judgments with respect to any financial instrument, issuer, security, or sector that may be described or referenced herein and does not represent a formal or official view of AQR.

The views expressed reflect the current views as of the date hereof, and neither the author nor AQR undertakes to advise you of any changes in the views expressed herein. It should not be assumed that the author or AQR will make investment recommendations in the future that are consistent with the views expressed herein, or use any or all of the techniques or methods of analysis described herein in managing client accounts. AQR and its affiliates may have positions (long or short) or engage in securities transactions that are not consistent with the information and views expressed in this presentation.

The information contained herein is only as current as of the date indicated and may be superseded by subsequent market events or for other reasons. Charts and graphs provided herein are for illustrative purposes only. The information in this presentation has been developed internally and/or obtained from sources believed to be reliable; however, neither AQR nor the author guarantees the accuracy, adequacy, or completeness of such information. Nothing contained herein constitutes investment, legal, tax, or other advice, nor is it to be relied on in making an investment or other decision.

There can be no assurance that an investment strategy will be successful. Historic market trends are not reliable indicators of actual future market behavior or future performance of any particular investment, which may differ materially, and should not be relied upon as such. Target allocations contained herein are subject to change. There is no assurance that the target allocations will be achieved, and actual allocations may be significantly different from those shown here. This presentation should not be viewed as a current or past recommendation or a solicitation of an offer to buy or sell any securities or to adopt any investment strategy.

The information in this presentation might contain projections or other forward-looking statements regarding future events, targets, forecasts, or expectations regarding the strategies described herein and is only current as of the date indicated. There is no assurance that such events or targets will be achieved and might be significantly different from that shown here. The information in this presentation, including statements concerning financial market trends, is based on current market conditions, which will fluctuate and may be superseded by subsequent market events or for other reasons. Performance of all cited indices is calculated on a total return basis with dividends reinvested.

The investment strategy and themes discussed herein may be unsuitable for investors depending on their specific investment objectives and financial situation. Please note that changes in the rate of exchange of a currency might affect the value, price, or income of an investment adversely. Neither AQR nor the author assumes any duty to, nor undertakes to update forward-looking statements. No representation or warranty, express or implied, is made or given by or on behalf of AQR, the author, or any other person as to the accuracy and completeness or fairness of the information contained in this presentation, and no responsibility or liability is accepted for any such information. By accepting this presentation in its entirety, the recipient acknowledges its understanding and acceptance of the foregoing statement. Diversification does not eliminate the risk of experiencing investment losses. Broad-based securities indices are unmanaged and are not subject to fees and expenses typically associated with managed accounts or investment funds. Investments cannot be made directly in an index.

HYPOTHETICAL PERFORMANCE RESULTS HAVE MANY INHERENT LIMITATIONS, SOME OF WHICH, BUT NOT ALL, ARE DESCRIBED HEREIN. NO REPRESENTATION IS BEING MADE THAT ANY FUND OR ACCOUNT WILL OR IS LIKELY TO ACHIEVE PROFITS OR LOSSES SIMILAR TO THOSE SHOWN HEREIN. IN FACT, THERE ARE FREQUENTLY SHARP DIFFERENCES BETWEEN HYPOTHETICAL PERFORMANCE RESULTS AND THE ACTUAL RESULTS SUBSEQUENTLY REALIZED BY ANY PARTICULAR TRADING PROGRAM. ONE OF THE LIMITATIONS OF HYPOTHETICAL PERFORMANCE RESULTS IS THAT THEY ARE GENERALLY PREPARED WITH THE BENEFIT OF HINDSIGHT. IN ADDITION, HYPOTHETICAL TRADING DOES NOT INVOLVE FINANCIAL RISK, AND NO HYPOTHETICAL TRADING RECORD CAN COMPLETELY ACCOUNT FOR THE IMPACT OF FINANCIAL RISK IN ACTUAL TRADING. FOR EXAMPLE, THE ABILITY TO WITHSTAND LOSSES OR TO ADHERE TO A PARTICULAR TRADING PROGRAM IN SPITE OF TRADING LOSSES ARE MATERIAL POINTS THAT CAN ADVERSELY AFFECT ACTUAL TRADING RESULTS. THERE ARE NUMEROUS OTHER FACTORS RELATED TO THE MARKETS IN GENERAL OR TO THE IMPLEMENTATION OF ANY SPECIFIC TRADING PROGRAM, WHICH CANNOT BE FULLY ACCOUNTED FOR IN THE PREPARATION OF HYPOTHETICAL PERFORMANCE RESULTS, ALL OF WHICH CAN ADVERSELY AFFECT ACTUAL TRADING RESULTS. The hypothetical performance results contained herein represent the application of the quantitative models as currently in effect on the date first written above, and there can be no assurance that the models will remain the same in the future or that an application of the current models in the future will produce similar results because the relevant market and economic conditions that prevailed during the hypothetical performance period will not necessarily recur. Discounting factors may be applied to reduce suspected anomalies. This backtest's return, for this period, may vary depending on the date it is run. Hypothetical performance results are presented for illustrative purposes only. In addition, our transaction cost assumptions utilized in backtests, where noted, are based on AQR Capital Management LLC's, ("AQR's") historical realized transaction costs and market data. Certain of the assumptions have been made for modeling purposes and are unlikely to be realized. No representation or warranty is made as to the reasonableness of the assumptions made or that all assumptions used in achieving the returns have been stated or fully considered. Changes in the assumptions may have a material impact on the hypothetical returns presented. Actual advisory fees for products offering this strategy may vary.

There is a risk of substantial loss associated with trading commodities, futures, options, derivatives, and other financial instruments. Before trading, investors should carefully consider their financial position and risk tolerance to determine whether the proposed trading style is appropriate. Investors should realize that when trading futures, commodities, options, derivatives, and other financial instruments, one could lose the full balance of their account. It is also possible to lose more than the initial deposit when trading derivatives or using leverage. All funds committed to such a trading strategy should be purely risk capital.

AQR Capital Management, LLC, is exempt from the requirement to hold an Australian Financial Services License under the Corporations Act 2001 (Cth). AQR Capital Management, LLC, is regulated by the Securities and Exchange Commission ("SEC") under the United States of America laws, which differ from Australian laws. Please note that this document has been prepared in accordance with SEC requirements and not Australian laws. Canadian recipients of fund information: These materials are provided by AQR Capital Management (Canada), LLC, Canadian placement agent for the AQR funds. Please note for materials distributed through AQR Capital Management (Asia): This presentation may not be copied, reproduced, republished, posted, transmitted, disclosed, distributed, or disseminated, in whole or in part, in any way without the prior written consent of AQR Capital Management (Asia) Limited (together with its affiliates, "AQR") or as required by applicable law.

This presentation and the information contained herein are for educational and informational purposes only and do not constitute and should not be construed as an offering of advisory services or as an invitation, inducement, or offer to sell or solicitation of an offer to buy any securities, related financial instruments, or financial products in any jurisdiction.

Investments described herein will involve significant risk factors, which will be set out in the offering documents for such investments and are not described in this presentation. The information in this presentation is general only, and you should refer to the final private information memorandum for complete information. To the extent there is any conflict between this presentation and the private information memorandum, the private information memorandum shall prevail.

The contents of this presentation have not been reviewed by any regulatory authority in Hong Kong. You are advised to exercise caution, and if you are in any doubt about any of the contents of this presentation, you should obtain independent professional advice.

The information set forth herein has been prepared and issued by AQR Capital Management (Europe), LLP, a UK limited liability partnership with its registered office at Charles House 5–11 Regent Street, London, SW1Y 4LR, which is authorized by the UK Financial Conduct Authority ("FCA") .

AQR, a German limited liability company (Gesellschaft mit beschränkter Haftung; "GmbH"), is authorized by the German Federal Financial Supervisory Authority (Bundesanstalt für Finanzdienstleistungsaufsicht, „BaFin") to provide the services of investment advice (Anlageberatung) and investment broking (Anlagevermittlung) pursuant to the German Banking Act (Kreditwesengesetz; "KWG"). The Complaint Handling Policy for German investors can be found here: https://ucits.aqr.com/.

Exhibit 3: Notes: Governance correlates with excess returns: Panel A shows evidence for public equities (MSCI World universe, stocks sorted on Governance, measured as accruals/assets; returns in excess of MSCI World index, data shown covers the period January 1, 1990 – December 31, 2017); Panel B shows evidence for credit (BAML Global Broad Corporate Index universe, issuers sorted on Governance, measured as accruals/assets; returns in excess of duration-matched Treasuries, data shown covers the period December 1, 1996 – June 28, 2019); Panel C shows evidence for emerging markets sovereign fixed income (5-year CDS within JMP EMBI+ universe, issuing countries sorted on 12M expected inflation as a proxy for central bank independence; credit-adjusted returns, data shown covers the period January 1, 2003 – December 28, 2018). Strong governance includes stocks and issuers in the quintile with lowest accruals ratios and bonds in the quartile with the lowest 12M expected inflation.

Exhibit 4: Data from February 2008 to September 2016. Hypothetical gross returns in USD. Hypothetical AQR Sustainable Style Premia: Long-Only Equity Strategy backtest. Universe and benchmark: MSCI World. We use Barra Integrated Model Long-Term (BIMDEV_301L). We show varying results of portfolio returns by targeting higher ESG scores for the entire portfolio. Portfolios are rebalanced monthly. ESG score provided by MSCI.

Exhibit 6: Data from February 2008 to September 2016. Hypothetical gross returns in USD. Hypothetical AQR Sustainable Style Premia: Long-Only Equity Strategy backtest with carbon overlay. Universe and benchmark: MSCI World. We use Barra Integrated Model Long-Term (BIMDEV_301L). We show varying results of portfolio returns by targeting higher carbon-intensity score reduction for the entire portfolio. Portfolios are rebalanced monthly. Carbon-intensity score provided by Trucost.

285498

www.aqr.com