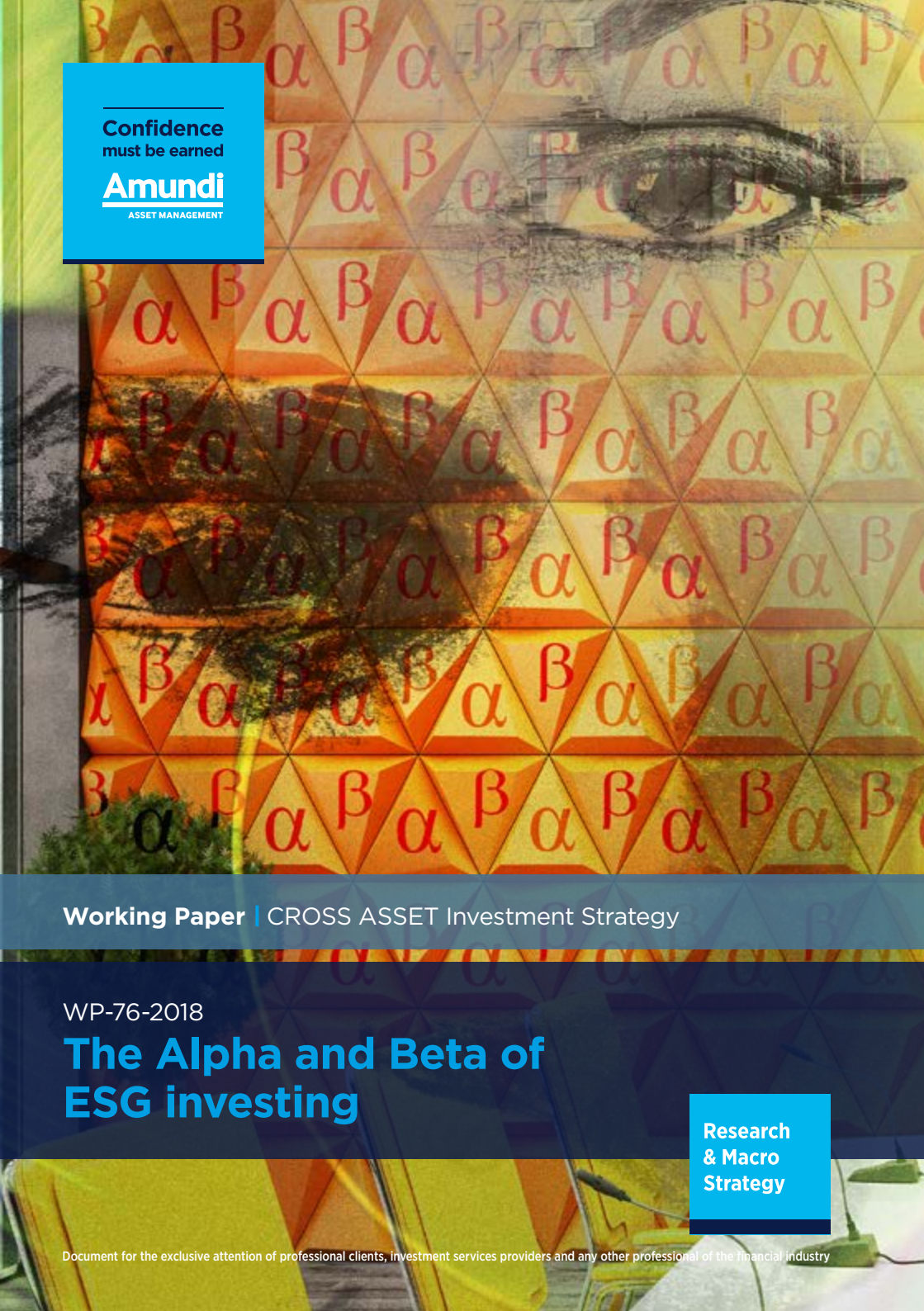

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Working Paper | CROSS ASSET Investment Strategy

WP-76-2018

The Alpha and Beta of ESG investing

Research & Macro Strategy

The Alpha and Beta of ESG investing

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Summary

Interest in ESG investing has grown incontestably in recent years. This study covers the analysis of the risk-return profile of ESG as a selection strategy on global developed markets, and the integration effects of ESG in an index-linked management process. Findings are contrasted for each E, S and G pillar, as well as ESG both on timing and region. However, since the start of 2014, we find a steep transformation in reward. Combined with growing investor interest in ESG, the transformation is of such a magnitude that we have taken a cross-section approach to determine whether ESG can stand up as a factor on its own.

Until 2014, ESG best-in-class strategies provided neutral or slightly negative results. Focusing on shorter periods brings to light a positive selection effect on highly rated companies, sometimes combined with the underperformance of poorly rated stocks. We also found not a significant positive effect on drawdown reduction. The Eurozone and North America are particularly responsive to ESG integration, with a higher reward for governance and environmental pillars, respectively. Social began to be rewarded in 2016, and since then it is catching up. Extra-financial pricing is non-linear. For instance, in the Eurozone, This study reveals a S-shape performance payoff using portfolios sorted by both ESG and governance scores. The performance shape is different in North America, as it only displays a positive premium in environmental and ESG best-in-class portfolios, while for the governance and social components worst-in-

class are penalized. In Europe ex-EMU and Japan, extra-financial results are mixed. The performances in Europe ex-EMU are not significantly different from zero; it also appears that the integration of E, S and G components is country-specific. In Japan the best-in-class excess returns are slightly negative despite the Abenomic's reforms. The results obtained are not stable, as they vary with the weighting schemes.

ESG integration in the optimization process entails a tracking-error risk and broadly brings positive excess returns over recent periods. The performance results are in line with the sorted portfolios analysis and also shows an increasingly positive effect on drawdown reduction. Tracking error induced by this process is limited and quite stable over time. Governance's contribution to tracking error is higher than the other two pillars.

Starting from 2014, the emergence of ESG performance raises the concern of the mutation of ESG from an alpha source of performance for active management to a beta source, feeding the booming factor investing industry. To evaluate the integration of ESG within a multi-factor framework, we performed both cross-section and time-series analyses. We demonstrate that the explanatory power of extra-financial factors used as stand-alone variables in a regression model is slightly above other style factors. On the other hand, the introduction of ESG and pillars (E, S and G considered individually) in multi-factor regression models does not significantly change the R-squared compared to the ones obtained by the traditional five-factor model (size, value, momentum, low volatility, quality). Nevertheless, we note that the ESG factor is significant in the Eurozone. Therefore, we introduce a selection methodology in order to identify the ranking that should be attributed to ESG among general style factors. ESG appears to be the first factor to be selected in the Eurozone, followed by the value, while in North America the first factor was quality and the second one was ESG. This analysis demonstrates the existing interaction between extra-financial and historically identified factors. Subsequently, a correlation study was performed, revealing that the integration of ESG in Eurozone participates fully in the diversification effect.

Given the increasing interest for a sustainable investing, the integration of extra-financial factors makes it possible to lay a foundation stone for future active management approaches. The perspective of building relevant pricing models using a different set of parameters, namely the extra-financial ones, is clearly relevant in the Eurozone. Even if this assertion is more questionable for North America, in a forward-looking perspective, ESG appears to be a very serious candidate to join the very exclusive club of style factors.

About the authors

Leila Bennani

Leila Bennani joined Amundi in 2008 as a Front Office Business Analyst within the Project Development Front Office team. Since September 2014 she's working as a quantitative analyst within the equity quantitative research. She worked on portfolio construction, smart beta and factor investing strategies. Since 2017, she is dedicated to ESG and climate studies, also in incorporating these considerations into portfolio strategies. Leila holds a Master's Degree in Engineering from ENSEIRB, as well as a Master's Degree in Economic and Financial Risk from university of Bordeaux.

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Lai Ly

Lai Ly joined Amundi ESG Analysis in August 2017 as Deputy Head and was promoted Head of the team in April 2018. With over 20 years of experience in credit analysis on the European, US and Asian markets, Lai has been integrating ESG factors in credit analysis since 2010. She has also gathered over 8 years of experience in managing research teams. She was previously based in Singapore for 6 years to build and grow Amundi's Credit Analysis expertise in Asia-ex Japan.

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Vincent Mortier is Deputy Chief Investment Officer (CIO) and an Executive Board member at Amundi. He also oversees Amundi's business in Greater China and South-East Asia. He has been working in the investment industry since 1996 and has been with the Group since 2015. He was also Global Head of Multi-Asset until July 2017. Vincent started his career at Société Générale in 1996. He held several senior positions within the Group, rising to the position of Chief Financial Officer of the Global Banking and Investor Solutions (GBIS) division in 2013. He was previously CFO of Société Générale Corporate and Investment Banking (SG CIB), Co- Head of Equity Finance (SG CIB) and Head of Strategy and Development - Global Equities and Derivatives Solutions (SG CIB). He also sat on the SG GBIS Executive Committee. Vincent holds an MBA from ESCP Europe Business School.

Takaya Sekine

Takaya Sekine joined Amundi in 2000 and is Deputy Head of Quantitative Research since July 2018. Prior to that, he was Deputy CIO at Amundi Japan (between 2011 and 2018), Head of Index and Multi-strategies at Amundi Japan (between 2010 and 2011), Fund Manager (between 2007 and 2010) and Financial Engineer (between 2001 and 2007). Takaya began his career as an IT Manager at Amundi Japan's predecessor company (between 2000 and 2001). Takaya is a CFA Charter holder since 2005, and an Associate member of the Association of Certified Fraud Examiners since 2010. He received the Ingénieur Civil des Mines degree from Ecole des Mines de Nancy in 2000. He has been involved in macroeconomic and policy related investment strategies.

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Key findings

- ESG measures are qualitative and multi-dimensional metrics, meeting varying standards.
- Academic findings are highly dependent on the period, universe, methodology, hypothesis and ESG data.
- We observe a radical change in the ESG-based investment strategy during the study period, from January 2010 to December 2017. In the first half of the period (2010-2013), it seems that using ESG scores in portfolio construction would have led to neutral or negative results. In contrast, the second sub-period (2014-2017) is much more beneficial to ESG strategies whether they are implemented through active or passive frameworks.
- E, S, G and ESG screenings have both a time- and region-varying impact on performance and risk, and the results sometimes depend on strategies.
- We replicated an active management framework by creating portfolios sorted by their extra-financial scores. We highlight the following points:
    - ESG integration in North America is becoming more and more perceptible, it has evolved from a negative effect between 2010 and 2013 to a positive shift in trend between 2014 and 2017, especially for the environmental pillar.
    - In the second sub-period, ESG and E integration in North America reward the best quintiles, while for S and G components the positive excess return comes from the worst-in-class penalization.
    - In the Eurozone, ESG is becoming increasingly integrated into prices for every pillar and especially for the governance one. From 2014, the Eurozone rewards best practices and penalizes the worst-in-class, except for the environmental pillar.
    - Social screening was not rewarded until end of 2015, but a substantial shifting up since 2016 for both North America and Eurozone has been noted.
    - Europe ex-EMU's integration is country specific: governance overweights UK, while social and environmental's best-in-class selection picks Norwegian or Swedish stocks.
    - ESG integration in Japan has not occurred despite Abenomics reforms; the risk-reward is not stable over time and is not robust across methodologies.
    - In the global developed market universe, middle quintiles are not appreciably affected by ESG integration; the discrimination is

mostly between best-in-class and worst-in-class stocks. Best-in-class is rewarded while the worst-in-class is penalized.

- Except for governance, ESG integration comes with a size bias from overweighting large capitalisations. It's important to notice that the performance is not explained by overweighting the large capitalizations but from the selection of well performing stocks.

- Focusing on a passive management framework, we set up an optimized index portfolio process, which provides the following:
  - There is no free lunch. Increasing the ESG excess score entails the tracking error risk. On average, improving the ESG score by 0.5 implies a tracking error of 30 bps.
  - Regardless of the universe considered, decomposing the tracking error among the E, S and G components shows that governance is the highest contributor to tracking error. This is due to its low correlation with E and S scores.
  - Results differ according to time and regions, in line with those obtained with the stock picking framework.
  - In the first sub-period, excess returns are globaly neutral or negative for ESG-based optimized portfolios. In the second period, increasing excess score provides excess return. There is, however, a breaking point from which, increasing the ESG excess score raises diversification issues and negatively impacts the linear trend of the excess return.
  - Results on pillars are also very different. In North America and on the second sub-period, environment is by far the most rewarded pillar while the governance largely dominates the two others (E and S) in Europe.
- Introducing ESG in a factor investing framework, we underline:
  - The results on single and multi-factor frameworks on the cross-section and time-series analysis, demonstrate that ESG is a significant factor in the Eurozone, but not in North America.
  - Introducing the ESG hypothetical factor within the traditional five-factor model and using a statistical selection method, we identify the most pertinent explanatory variables to explain MSCI benchmark total returns. In the Eurozone, ESG appears to be the first selected factor, ahead of value and momentum risk factors. In North America, the first selected factor is quality and the second one is ESG.
  - A correlation study confirms that ESG can enhance the diversification of multi-factor portfolios in the Eurozone. In North America, the results are more mixed.

- Backward looking, ESG seems not to be a new risk factor in North America whereas ESG could improve the diversification of multi-factor portfolios in the Eurozone.
- Forward looking, ESG appears to be a very serious candidate to join the very exclusive club of style factors that explain the cross-section of stock returns.

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I. Introduction

What is the relationship between companies' environmental, social and governance (ESG) characteristics and their financial performance? In this paper, we determine to what extent extra-financial information is relevant and how it adds value in investment processes by searching for quantitative relationships between corporate financial performance (CFP) and the breakdown of extra-financial characteristics.

To some extent, this question recalls the notable shareholder vs. stakeholder debate, also known as the Friedman vs. Freeman debate (1970 and 1983), opposing shareholder and stakeholder orientations and their importance for long-term business sustainability. This debate is known to be potentially ideologically and emotionally biased. Some studies have also suggested that this relationship may be subject to changes in societal mentality. Van Beurden and Gössling (2008), for instance, revealed a change in the correlation between corporate social responsibility (CSR) and financial performance, suggesting that ethical businesses are becoming more likely to be rewarded as "*societies have changed*". Campbell (2007) brought an important contribution to the literature on this subject by assessing a set of conditions allowing firms to behave responsibly. Indeed, most studies focus on the performance obtained by companies acting in a responsible way, based on a set of criteria, but do little to evaluate to what extent external conditions, possibly including corporate financial performance itself, might also generate a favorable environment for more responsible behaviors. This raises the question of causality, which is at the heart of the debate, but academic research has not found conclusive results on this aspect.

The growing number of studies aiming at quantifying the effects of extra-financial notations on performance has provided no real enlightenment, as their results are usually not extendable and are sometimes even conflicting. Aggregating these results, the forerunning meta-analysis from Orlitzky *et al.* (2003) and Margolis *et al.* (2009) revealed a positive correlation between social performance and CFP measured by stock market capitalization and accounting indicators. However, Renneboog *et al.* (2008) found no significant effect of socially responsible investment and conclude that "*the existing studies hint but do not unequivocally demonstrate that SRI investors are willing to accept suboptimal financial performance to pursue social or ethical objectives*". In a more practical view, the impact of ESG headlines and events on the CFP has also been assessed by Krüger (2015). The study showed that abnormal negative returns usually follow the release of unfavorable news, but no significant positive effects follow the good news. This result would encourage investors to use ESG as a risk indicator and to implement negative screening more than using it as a source of profit.

The set of influential parameters is so large that it may seem presumptuous to identify an explicit relationship between ESG scores and performance variation. To avoid the overlay implied by this multi-dimensionality in the fractured and sometimes highly qualitative framework in which CSR is defined, some have focused on more measurable behaviors. For instance, Derwall *et al.* (2005) assessed the impact of eco-efficiency, which can be defined as the ratio between goods produced and resources consumed. They revealed that portfolios constructed using a "best-in-class approach" generate higher alpha in a multi-factor framework. As a follow-up of this work, Guenster *et al.* (2011) demonstrated that market valuation variations have been time-varying, which led them to conclude that the incorporation of environmental information may come with a time delay. Corten *et al.* (2005) also showed that higher sustainability ratings entailed higher performance in the Eurozone, implying, however, a strong style bias that can affect performance. Bauer *et al.* (2009) focused on the relationship between employees' relationships and the firm's credit risk. Their main finding is that better employee relationships reduce financing cost and increase credit ratings. Methodologies based on sub-criteria materiality have gained in popularity and some more contemporary papers, for example Khan *et al.* (2016), have shown that ESG screening on industry specific material criteria generate some outperformance, while other criteria, on "immaterial sustainability" issues, do not significantly outperform.

The broader impact of ESG profiles on financial metrics, such as cost of equity capital, has also largely been assessed in the academic literature. Both El Ghoul *et al.* (2011) and Goss and Roberts (2011) demonstrated that better CSR scores lead to cheaper equity financing and that the lowest-scoring companies had to pay more, implying that "*socially responsible practices have higher valuation and lower risk*". On the other hand, some studies (Hong and Kacperczyk, 2009) have shown that portfolios excluding some companies because of their social practices have historically underperformed. This study particularly demonstrated that sin stocks[1] are underpriced and provide comparable returns. While other research, such as index or portfolio-based studies, leads to neutral results. For instance, Schröder (2007)[2] found that there is no significant effect of responsibility on risk adjusted returns.

Other studies explored ESG investing in a broader perspective by comparing results according to hypothesis, period and criteria assessed among environmental, social and governance pillars. A cross-section analysis was realized by the United Nations Environment Programme Finance

[1] *"Sin stocks" refers to companies involved in controversial businesses such as weapon, nuclear energy, alcohol, tobacco, pornography, gambling, etc.*

[2] *Study performed on the entire historical of the World and Europe indexes until 2003.*

Initiative Asset Management Working Group and Mercer (2007). This meta-study can be used to analyze and compare the results of studies that predate it. The first part considers twenty academic papers and shows that environmental and governance screenings always seem to have a neutral or quite positive influence on portfolio performance but also that social screening can harm diversification and have a negative impact Geczy *et al.* (2003). The second part reports the results of brokers' studies that were mainly neutral. Schröder (2014) performed an academic review of the literature aggregating results and comparing the findings of studies since 2005.

This short review of the academic literature gives an insight into the diversity of the results obtained by researchers over time. Indeed, results have been found to be highly dependent on both period and universe, but especially on methodology, hypothesis and data used. For instance, while pointing out that roughly 90% of studies reported positive correlations between ESG and CFP, Friede *et al.* (2015) also implicitly showed that the results depend on the type of study. They showed, for instance, that portfolio-based studies present mostly neutral or mixed results while non-portfolio studies were mainly positive. Furthermore, methodologies based on transmission channels (Giese *et al.*, 2017) that go from ESG profile to higher dividends can highlight causation between a high ESG profile and a higher profitability. However, ESG selection can negatively affect portfolios performance by harming diversification (e.g., Chong *et al.* (2006). Therefore, the choice of methodology, cross-section causation or portfolio back-testing, not only matters but is also likely to give different conclusions.

It therefore appears that the main challenge lies in the choice of the methodology and the data selected. This study aims at assessing the effect of ESG integration on more recent data[3], and to insert extra-financial scores into financial standard analysis systems. To expose the specificities related to the pricing of ESG pillars in the global market, we followed a bottom-up methodology, evaluating the impact on financial performance of the breakdown of the global scores according to E, S and G pillars, in each region of developed equity markets. This paper also presents a broad assessment of the use of ESG metrics in both active and index management and also factor investing strategies.

This study is structured as follows. In section two, we present investors' motivations for incorporating ESG into their portfolios strategies, and we define different SRI approaches. In section three, we study the alpha generated by ESG through two different methodologies corresponding to the main approaches of ESG investing. We first replicate an active management framework by creating portfolios sorted by their ESG scores and then, we

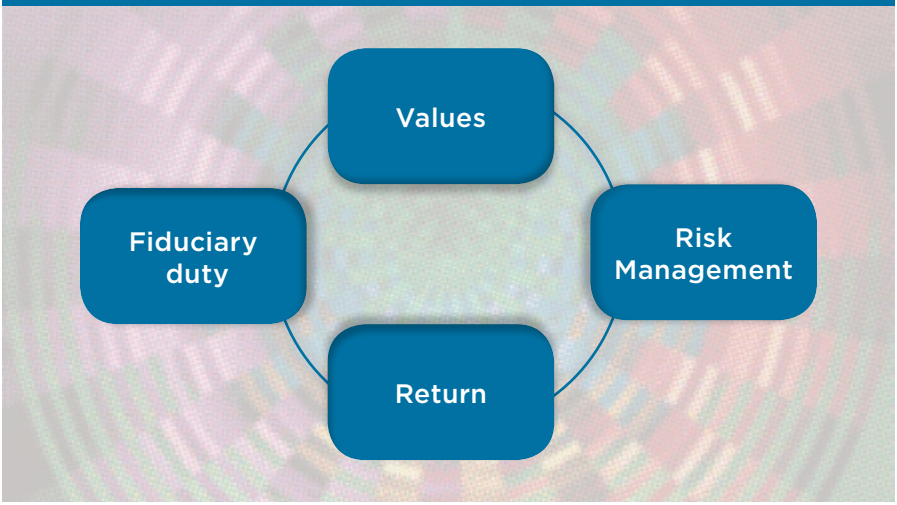
[3] *Focusing on periods of high coverage.*

focus on passive management, setting up an optimized index portfolio process. To highlight the regional specificities of ESG integration, this study was done on different developed regions and focused on two periods, 2010-2013 and 2014-2017, to assess a potential change in trend. Section four tackles the topic of ESG and factor investing, using three complementary methodologies. First, we analyze the integration of ESG, and then E, S and G components as exogenous variables in both cross-section and time-series approaches, in order to assess the incremental explanatory power of this new factor. Second, we implement a lasso (Least Absolute Shrinkage and Selection Operator) selection model to identify the most pertinent explanatory variables in our n-factor model. And finally, we analyze the exposure of the ESG factor to other well-known style factors and we measure their correlations using a hierarchical clustering methodology.

II. ESG investing landscape

Responsible Investing is used to express values and to improve investment performance by using additional resources. However, this concept has changed and has varying meanings in the literature. Eccles and Viviers (2011) gave an academic definition of responsible investment as "*investment practices that integrate a consideration of ESG with the primary purpose of delivering higher-risk-adjusted financial returns*". The demand expressed by investors addresses different motivations and requirements, in accordance with their heterogeneous beliefs (Figure 1), defined below:

Figure 1: Example of ESG investing motivations



- **Values:** responsible investment could support investors' core or ethical values, e.g., divestment in sectors such as alcohol, tobacco, weapons, etc.
- **Risk Management:** responsible investors consider that ESG factors complement financial analysis and thus provide a 360 degree assessment of risks.
- **Return:** not only does ESG participate in negative screenings (risk approach), investors also increasingly expect ESG to produce a positive return on their investments, be it financial or non-financial (e.g., impact).
- **Fiduciary duty:** investing within legal and regulatory frameworks, responsible investors have the duty to produce long-term returns on their investments while being responsible to society.

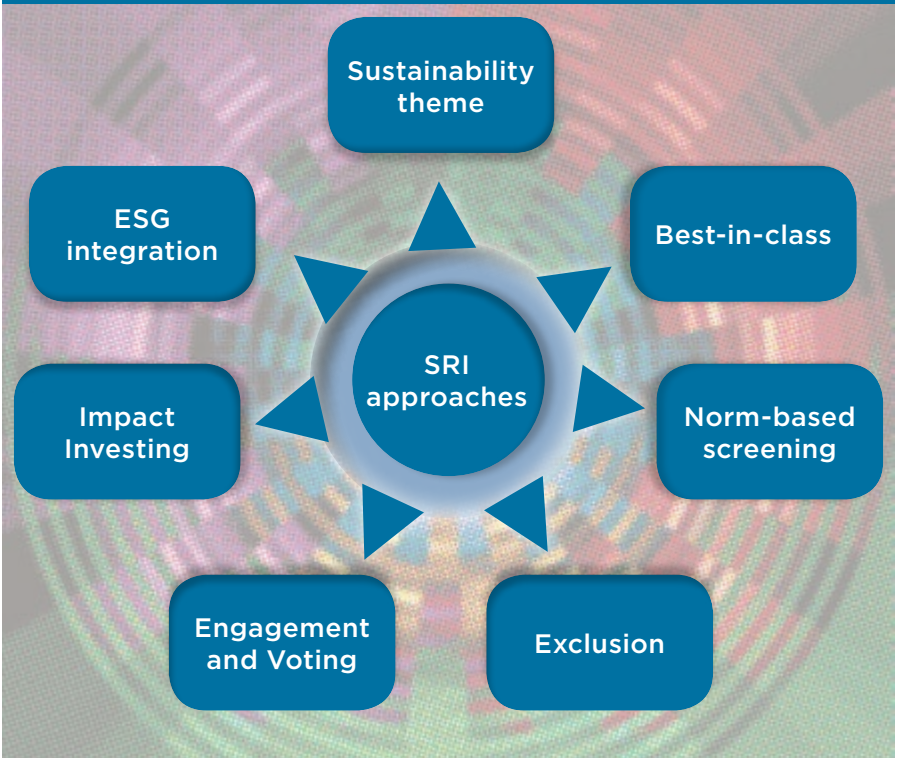
The ESG approach makes it possible to compare corporate or government issuers with respect to environmental, social and governance criteria. As an example, environmental scores are defined mainly as the aggregation of carbon emissions, biodiversity impact and water consumption. This score carries much of the information necessary to evaluate climatic impacts of companies, but requires some additions. The social dimension ensures respect for human rights, non-discrimination, health and safety, while governance assesses board independence, shareholders' rights and the company's business ethics.

ESG analysis helps to better identify risks and opportunities. This helps investors to take into account financial, regulatory, operational and reputational long-term risks, and to fully exercise their responsibility. To address this growing demand, Amundi's ESG analysis team provides reports and ratings to help portfolio managers implement responsible investment solutions for investors. The dual purpose of these analyses is to allow companies to adjust their behavior and to receive advice on how to improve their sustainable development policies to address market expectations in terms of environmental, social and governance requirements. Sustainable investment is also based on the idea of preserving the global economy from the systematic risks and global dysfunctionalities entailed by traditional behavior. Amel-Zadeh and Serafeim (2018) reveal that 82% of respondents consider ESG to be material to investment performance. Indeed, the global geopolitical environment is leading professional and institutional investors' concerns to drive a more virtuous cycle. This dynamic effect is likely to enhance both the performance of companies made "financially" attractive by their responsible practices and coverage in terms of ESG information that will improve future models. In terms of explicit added value of ESG signals, this consideration might raise the question of causation. In the field of system dynamics this process is called a reinforcing loop.

Such a trend could be considered as a momentum effect resulting from a form of "ESG integration trend following". While Berg et al. (2014) present ESG as a free option to exert values in terms of cost in performance, most contemporary studies show that ESG slightly enhances financial performance. In the current context, and the increase of political and media pressure on ESG-related issues, we can expect this dynamic to continue. Moreover, the prospect of outperformance can also be a condition allowing companies to act more responsibly. Some other studies approach ESG investing though other methodologies, for example using empirical survey to assess its integration based on behavioral asset pricing model, i.e., modeling investment decision patterns; results, however, cannot yet be generalized to a worldwide universe.

We can use a categorization of SRI strategies and ask if and how they can benefit from ESG scores. The Figure 2 presents the categories of strategies summarized by European SRI study (2012). These strategies can be combined by managers. Below, we defined the different strategies:

Figure 2: SRI approaches

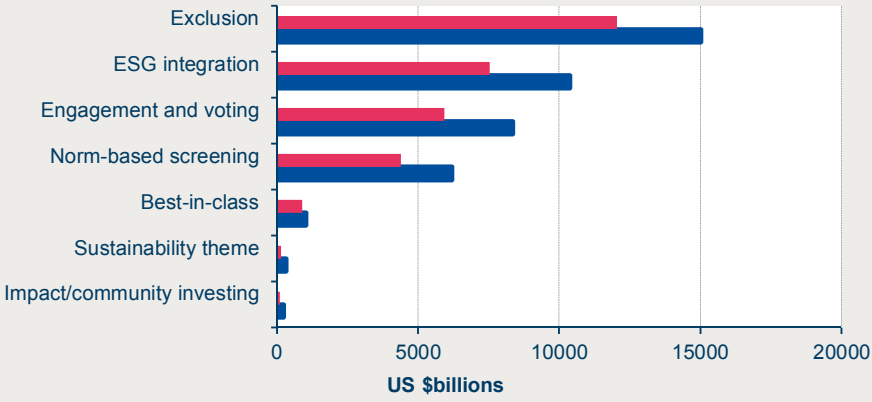


Source: European SRI study (2012)

- Sustainability theme: Investments focus on themes or assets classes specifically related to sustainability, such as clean and renewable energy, passive buildings and green technologies, sustainable agriculture. This type of investment focuses to some extent on ESG-related opportunities.
- Best-in-class: Positive screening, in contrast, focuses mainly on best-in-class companies. This form of responsible investment selects stocks that have a positive ESG performance relative to industry peers. It would be irrelevant to compare the characteristics of companies from different sectors, as they are not facing the same problematics; therefore, comparisons are performed within sectors bringing up the relative notion of "*best-in-class*".
- Norms-based screening: Investors can also express the willingness to invest in stocks that respect the minimum standards of business practices based on international conventions and principles. This type of investment is becoming mainstream especially for institutional investors.
- Exclusion: The most intuitive way to assert one's values is negative screening leading to strict exclusion policies. For example, it is common to exclude companies involved in weapons or tobacco, also referred as sin stocks. Van Duuren *et al.* (2016) have also shown that ESG was particularly used for "*red flagging*", i.e., as an indicator of risk. The previously quoted survey of Amel-Zadeh and Serafeim (2018) revealed, on the other hand, that negative screening appears to be the least beneficial in investment processes, which can be due to the outperformance of sin stocks demonstrated by Fabozzi *et al.* (2008) and Hong and Kacperczyk (2009).
- Engagement and voting: This is a form of responsible investment based on governance sub-criteria, board independence and, especially, shareholder rights, evaluating shareholder power to influence corporate behavior and to submit proposals.
- Impact investing: Refers to a process with the intention of generating a social and environmental impact together with a financial gain. While responsible investing encompasses avoidance of harm, impact investing targets a positive social and environmental effect.
- ESG integration represents the systematic use of ESG signals, scores or ratings into investment processes. It seems to be the only one suited for quantitative analysis and, more generally, makes it possible to mix all the strategies above, as the scores used in optimization system carry the information required to perform any other form of investment.

Responsible investing has gained much popularity in recent years. Figure 3 illustrates the importance of responsibility in the field of finance. The percentage of ESG funds is higher in Europe, but the rest of the world is catching up this growing trend.

Figure 3: Growth of responsible strategies between 2014 and 2016



Source GSIA: Global Sustainable Investment Review

The recent ESG integration into benchmarks (Giese et *al.*, 2018) also demonstrates that ESG-driven investment strategies are becoming widespread. They are now not only represented in stock picking and asset allocation decisions but also into passive investment strategies.

III. Performance of ESG investing

Some academic studies compare the performance obtained by SRI funds (Jegourel and Maveyraud, 2010) with those obtained by traditional funds, which can be biased by other active management decisions. In this study, we chose to assess the performance obtained by using extra-financial scores within the portfolio construction process. We firstly analyzed the data used and then considered the specificity of those data. Then, to shed some light on the relationship between financial performance and extra-financial metrics, we implemented two quantitative methodologies: ESG payoff analysis and assessment of risk and return implied by ESG score improvement.

Regarding the ESG payoff analysis, five equally-weighted portfolios were built based on extra-financial rankings at each rebalancing date. Quintile portfolios represent a level of extra-financial engagement. The first quintile is the best-in-class portfolio; it is the portfolio that contains the securities with the higher scores. This sorted portfolio study shows how ESG scores and sub-scores are integrated in equity market prices and highlights potential trends.

The optimized portfolios methodology consists of a progressive increase of the portfolio global score, making it possible understand the effects of the

dynamic ESG integration on different indexes. Tilted portfolios are obtained by an optimization process.

For both studies, we chose to delve different developed regions and focus on two time periods 2010-2014 and 2014-2017 seeking potential change in trends between 2010 and 2017 towards ESG integration.

3.1. Data

Extra-financial measure is a controversial subject, and the lack of measuring standards has been noted broadly, if not criticized. The construction of the score is a function of many variables. Eccles and Stroehle (2018) have recently analyzed different data sources, and approached the so-called *"fuzzy notion"* of sustainability viewed by different providers. They showed, for instance, that Vigeo-EIRIS scores emphasize qualitative values – accounting for 80% - while MSCI scores focus only on quantitative metrics. There is therefore a global data quality concern, including concerns about data collection methods, assessment subjectivity, definition of sector specific materiality (Eccles *et al.*, 2012), contradictory measuring standards, *"political correctness"* and inconsistent disclosure (Gray, 2012). This paper's objective is not to judge the construction of the extra-financial datasets but to focus strictly on the quantitative reward managers can expect when using these metrics in a portfolio construction.

The scores used in this study come from the Amundi's proprietary ESG rating process, which is certified by Afnor[4]. Amundi's ESG rating methodology combines:

- a proprietary definition of the most relevant ESG criteria by sector and weightings by criteria;
- data scores by criteria coming from a consensus of five ESG data providers.

This process is further enhanced by subsequent internal qualitative research, primarily through sectorial reviews, engagement and thematic researches analysis. This represents the internal assessment of the sector specific materiality (Eccles *et al.*, 2012). It also embeds the cultural disparities coming with providers' ESG scores construction. Indeed, Amundi's ESG rating methodology combining five data providers aims at mitigating this bias and reaching a consensus ESG score that should provide a stronger ESG measure than one relying on a single ESG viewpoint.

Issuers rated are public or private agents seeking resources to finance their investment. The scoring methodology is based on 15 generic criteria applied to all sectors, and 22 sector-specific criteria. Table 1 shows examples of general and specific criteria in environment, social and governance.

[4] *Afnor (Association Française de Normalisation) is the French national organization for standardization and its International Organization for Standardization member body.*

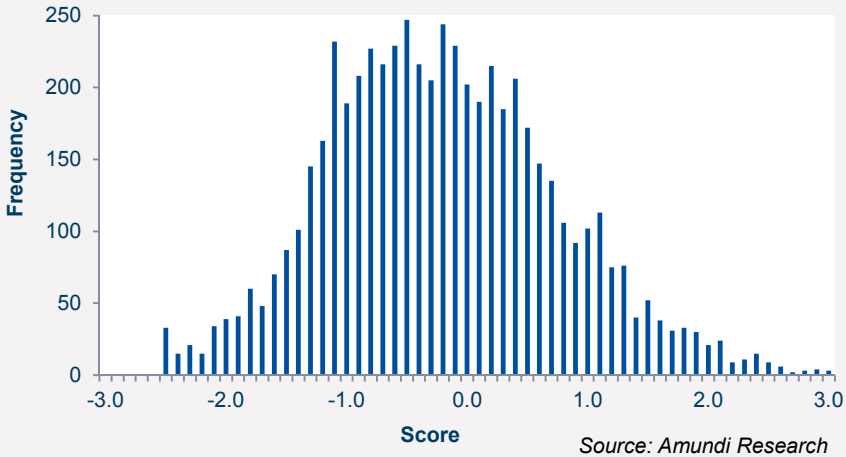
Table 1: Example of ESG Criteria		
E	S	G
GHG emissions & energy use	Employment conditions	Board independence
Water	Community involvement	Audit and control
Green cars*	Access to medicine*	Remuneration
Green financing*	Digital divide*	Shareholders' rights

*Specific criteria

The weight allocated to each criterion varies by sector, according to ESG analyst assessment. For instance, Table 2 shows that the environmental pillar is overweighted for the automobile sector, while the governance criteria are overweighted for the bank sector and social criteria for the pharmaceutical sector. This way, the assessment of criteria materiality is qualitatively performed and embedded in the scores.

Table 2: ESG example of weighting			
	E	S	G
AUTOMOTIVE	37%	37%	26%
BANK	24%	29%	47%
MINING	41%	36%	23%

Figure 4: Score distribution



Z-scores are normally distributed around sectorial average (Figure 4), neutralizing sector bias that could be entailed by the ratings. Scores do not depend on the universe; i.e., portfolios are universally rated, and the global score is computed as the weighted average score.

The change in ESG scores disclosure on the MSCI World Index allows us to study their impact on performance from 2010. Before that, the lack of information and inconsistency in the rating methodologies between the periods may strongly bias the result.

We decided to perform general studies, evaluating the aggregated ESG score and also E, S and G pillars. Therefore, we focused on the reward of good practices according to ESG analysts' assessment by quantifying the returns implied by their qualitative weightings methodology to build global scores. This way we avoid the risk of correlation mining between financial performance and ESG criteria that can have a sector specific and time varying materiality.

The issue of materiality is, however, at the center of discussions. Many asset managers attempt to define ESG materiality as a function of likelihood vs. potential impact, i.e., effects, of risks related to each criterion for different sectors or regions. From this ESG risk evaluation method; one can obtain a mapping using material criteria to assess the level of risk. For instance, utilities, materials and energy sectors seem to be particularly exposed to ESG-related risks. Ashwin Kumar *et al.* (2016) also revealed highly varying influence of ESG concerns on risk-adjusted performances for each industrial sector. Moreover, the panel of investor's values largely depends on the country and other religious (Louche *et al.* 2012), or cultural parameters. Van Duuren *et al.* (2016), for instance, highlighted substantial differences between Europe, U.K. and U.S. in terms of ESG views. We performed regional studies and distinguished extra-financial pricing on MSCI North America, MSCI EMU, MSCI Europe Ex- EMU, and MSCI Japan indices.

3.2. Rewarding goodness or taxing sins?

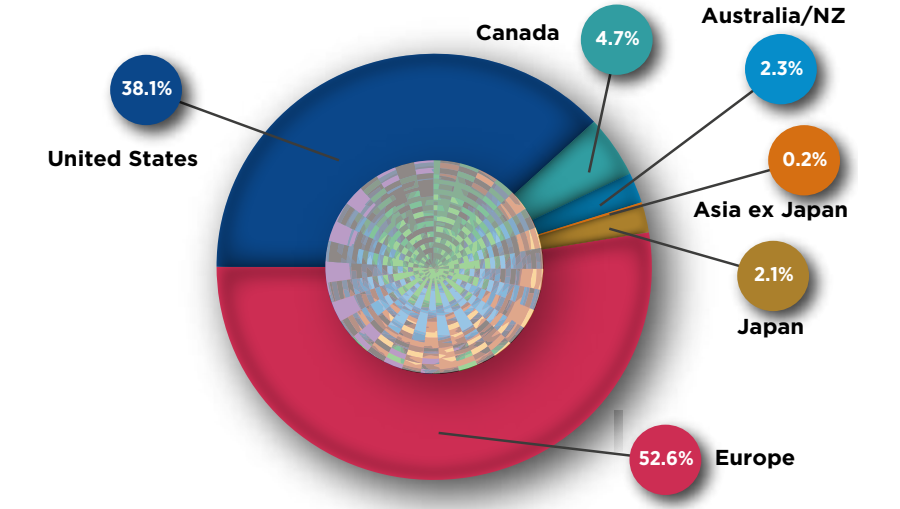
In this section, we carried out the payoff analysis methodology. This is a sorted-based approach of Fama and French (1992). At each rebalancing date we rank the stocks according to their score and we form five quintile portfolios. To focus on the information contained in the ratings and to eliminate sector and region biases, we choose a sector- and region-neutral equally-weighted allocation. The purpose is to compare the performance of the best and worst in terms of ESG scores to understand how the market has reacted to both responsible and controversial practices over time. It also gives an idea of the performance we can expect from implementing a purely best-in-class strategy. To perform this analysis, we computed the performance of the long/short portfolios, where we buy the best rated stocks and sell the worst ones.

Intermediate quintiles were also studied to assess the effect of ESG scores on their performance. Portfolios were reallocated quarterly between January 2010 and December 2017.

3.2.1. Regional heterogeneity in the pricing of responsibility

According to the Global Sustainable Investment Review 2016, nearly all regions saw an increase in their SRI assets, to an extent that varied from region to region (Figure 5). To highlight the regional specificity of extra-financial integration, we studied five of the most important indexes in developed market: the MSCI North America Index, MSCI EMU Index, MSCI Europe Ex-EMU Index, MSCI Japan Index and MSCI World Index. We computed their cumulative and annualized performances, and drawdowns of the quintiles portfolios. In a global universe, sector biases would have been minor considering that the rating methodology is sector-neutral over a universe counting 5000 issuers. However, building portfolios on smaller indexes, such as regional ones, might entail slight sector deviations we wanted to eliminate. Each quintile therefore represents a sector-neutral portion of its parent index. Portfolios generated might still contain a size bias that will be evaluated in this part.

Figure 5: Proportion of Global SRI assets by region in 2016



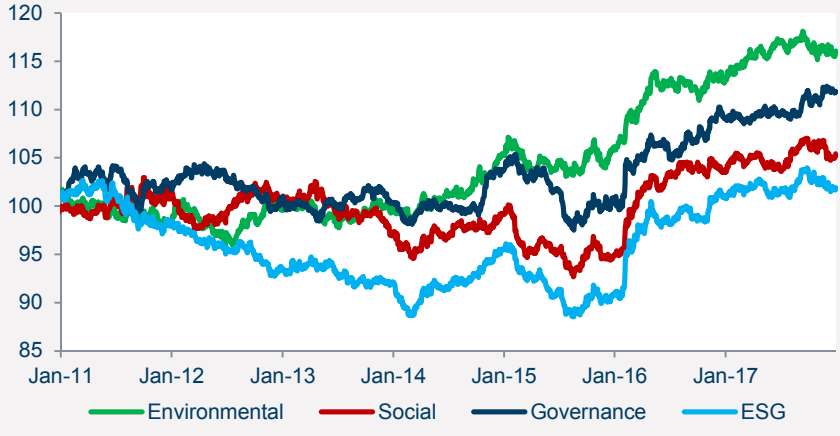
Source: Global sustainable investment review (2016)

North America

In the MSCI World Index, North American stocks account for more than 60% of the developed world's market capitalization. We can expect the ESG trend worldwide to be strongly influenced by the integration of extra-financial scores in this zone. To highlight the progressive integration of extra-financial

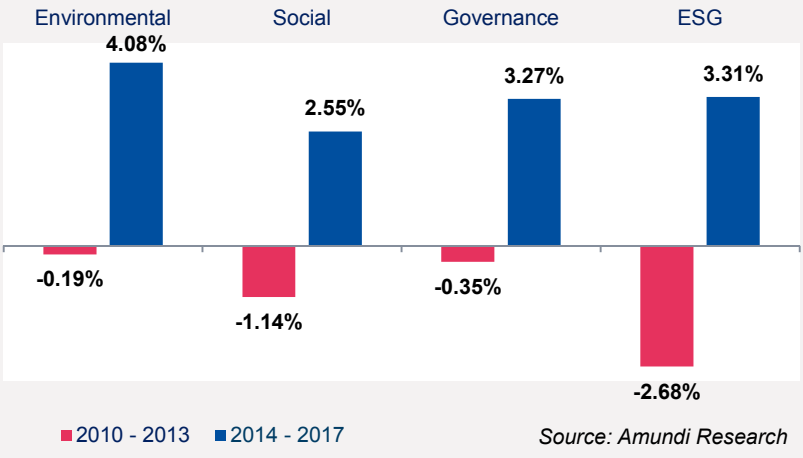
criteria over time we analyzed the performance of the long/short portfolios. Figure 6 presents the cumulative relative performances of these portfolios according to ESG and each pillar. Figure 7 summarizes the annualized performances obtained by these theoretical strategies on two focus periods.

Figure 6: Cumulative relative performance Q1 vs. Q5 [MSCI North America : 2010-2017]



Source: Amundi Research

Figure 7: Average annualized long/shorts returns [MSCI North America]



Source: Amundi Research

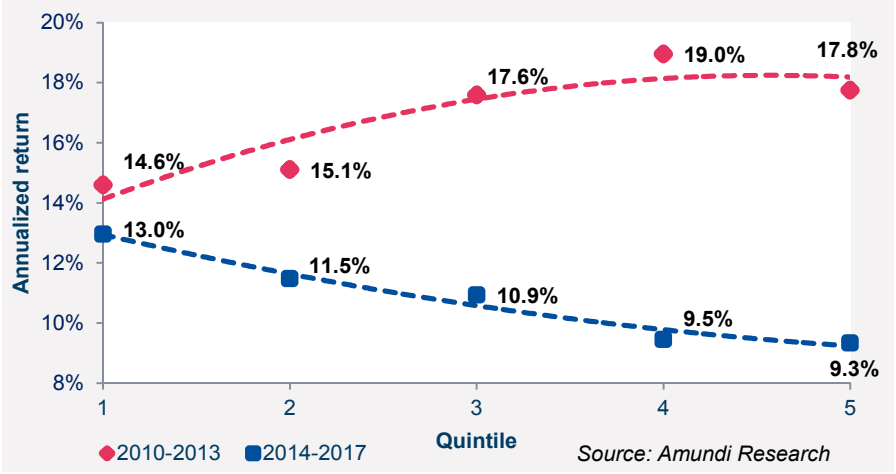
In terms of performance over the past few years, long/short strategies based on ESG scores all provide positive performance, which suggests that the best quintile outperformed the worst. Between 2010 and 2013, buying highly

extra-financial-rated securities and selling the worst ones would have led to neutral or negative excess returns (Figure 7). The trend has notably improved on every pillar including ESG global scores since 2014 (Figure 6), despite the decrease between 2015 and early 2016 caused by the Chinese crisis that has affected the global equity markets. Each extra-financial portfolio recovered strongly in 2016. The environmental long/short seems to be less affected, which could come from outperformance of the best-in-class in term of environmental scores, as well as the steeper depreciation of the worst.

To go further, we studied the performances of every quintile. Figures 8 and 9 display the average gross performances of each E and ESG quintile over the two periods. The polynomial relationships have no concrete materiality, but they do give an insight of the hidden added value of extra-financial information. They also reveal potential non-linear effects on performance carried in the scores. The relative position of each quintile characterizes the integration of ESG information in prices.

Figure 8 shows that ESG quintiles performance went from decreasing to increasing with the score, revealing that extra-financial metrics are increasingly integrated into prices. Indeed, sector-neutral quintiles average performances in North America were driven more by ESG scores rankings between 2013 and 2017, i.e., the worst ESG quintile had the lowest performance returning 9.3% while the best clearly outperformed others with an annualized return of 13%. We can observe an almost linear trend rewarding best global ESG practices.

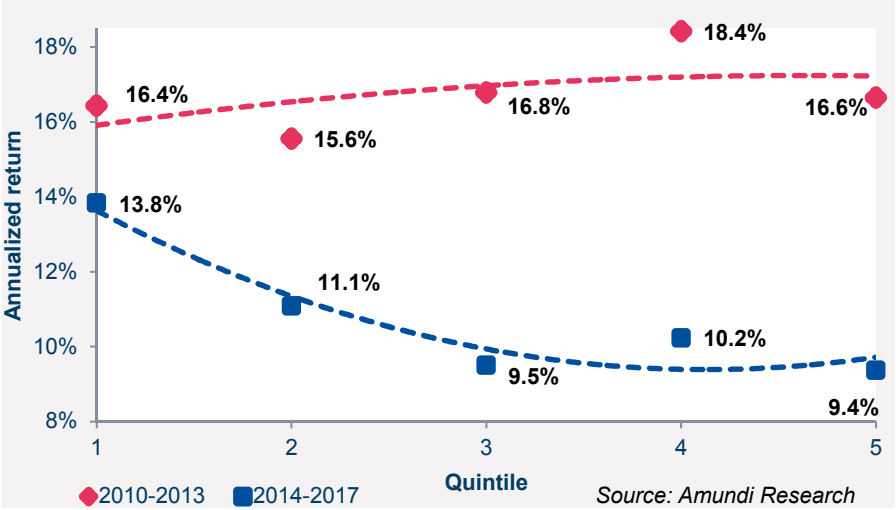
Figure 8: ESG performance of sorted portfolios [MSCI North America]



This quintile study confirms the quite neutral influence between 2010 and 2013, but an undeniably positive one over the second period. Indeed, Figure

9 shows that in second period, the best environmental quintile provides higher performances than any other ones. In this back-test, incorporation into market prices does not appear to be linear, i.e., affecting each quintile according its rank, and seem to be best-in-class-oriented. Another way to read these graphs would be to conclude that both ESG and E first quintiles have been less affected by the global reduction of return, i.e., higher-ranked quintiles have been more resilient over this period marked by market instability[5].

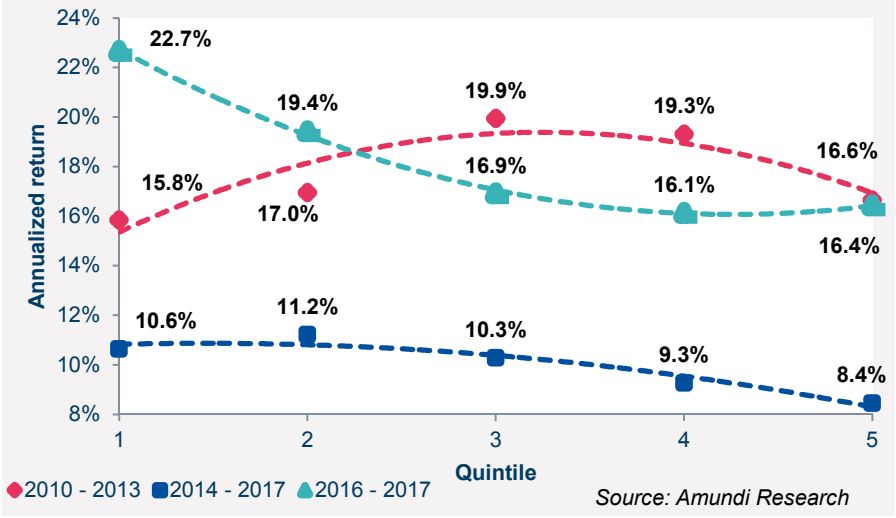
Figure 9: Environmental performance of sorted portfolios [MSCI North America]



Performing the same study on social and governance also shows some change in trends. The governance profile is different from the environmental profile. Indeed, Figure 1 in Appendix A shows no sign of integration of this pillar into prices in the first period, but a depreciation exclusive to the worst-in-class over the second. The social pillar in Figure 10 presents a trend shifting from concave – i.e., best and worst underperform the second, third and fourth quintile – to a slight increase of the performance with the social rank. However, it seems that social integration is following the same strong trend marked by the environmental criteria especially over the last two years.

[5] *The MSCI North America Index performed better in 2010-2013 than between 2015 and 2017, as the Chinese crisis strongly affected the U.S equity market, which tumbled between 24 August 2015 (the beginning of the crisis with -8.5% for Shanghai) and mid-January 2016 (source: MSCI).*

Figure 10: Social performance of sorted portfolios [MSCI North America]



Berg *et al.* (2014) showed that exposure to the size factor explained much of ESG integration strategies. Qualitatively, one can notice that ESG-related risks possibly affecting performance of frequently rebalanced portfolios – i.e., that have short term time horizons – are mostly reputational. This observation could imply that larger companies, with potentially greater media exposure, might suffer more from ESG risks in the pricing of their shares. Moreover, according to the analysis methodology, one can also consider that large caps have no excuse not to make the effort to invest and consider sustainability issues, as they have the financial means to do so. Large companies are therefore more likely to consider ESG criteria.

Quantitatively, the best equally-weighted quintiles are indeed underweighted on mid-caps and focus on larger ones. This study is based on equally-weighted portfolios, so these variations simply reflect that large caps have higher ESG, E and S scores. In the second period, G scores seem to be neutrally distributed. The active weights have not changed between the two periods, which indicates that the relationship between the market cap and extra-financial scores has not significantly changed, even if there is a slight reduction in differences magnitude, i.e., the effect of size on ESG investment process was slightly lower in the more recent period.

In the first period, the underperformance of the first quintiles entailed by the size allocation on mid and large caps was not balanced by the selection of well-performing stocks. On the contrary, the total selection effect implied by selecting best-in-class in terms of ESG global score was negative in North

America, which is confirmed by the decreasing trend in the first period (Figure 6). The use of the ESG signal in investment process would have mostly entailed distortions in portfolios compositions with no significant positive effect on performances, leading to a slight overall underperformance. In the second period, the first ESG quintile performance is driven by a strong positive selection effect of well performing mid-caps. Performance attributions of best and worst-in-class according to social pillar have profiles much alike ESG.

Environmental selection in North America focuses on large caps and underweights mid-caps over the whole period. However, even if the selection of companies that are highly E-rated and performing has not drastically changed. The allocation effect became positive in the most recent period, which explains the outperformance. The performance is driven by both mid and large-cap selection, with no influence of small-caps, which demonstrates the neutrality of the size effect on performances. There is no bias size for the long/short governance portfolio; the outperformance is driven only by a selection of, small, mid and large, well-performing stocks.

The US market is known to be especially driven by the GAFAs' performance[6]. This large-cap bias could imply that the outperformance of the best quintile comes from these companies. However, Google, Amazon, Facebook and Apple belong to the fourth, or if not the last, quintile, at least in term of ESG and S scores. In other terms, the ESG first quintile makes it possible to generate positive excess returns selecting large capitalizations, even though they have been slightly outperformed by mid-caps during both periods, without selecting any of the famous and well performing companies of the GAFA.

Table 3: Sorted portfolios drawdowns

	ESG		Environmental		Social		Governance	
	2010-2013	2014-2017	2010-2013	2014-2017	2010-2013	2014-2017	2010-2013	2014-2017
Q1	-23.64%	-19.89%	-22.89%	-18.70%	-22.84%	-21.30%	-23.38%	-23.74%
Q2	-22.10%	-21.29%	-22.34%	-18.13%	-22.75%	-18.58%	-23.90%	-19.75%
Q3	-24.23%	-22.59%	-23.35%	-23.84%	-21.69%	-20.42%	-22.69%	-18.96%
Q4	-21.83%	-22.35%	-22.23%	-22.00%	-21.13%	-22.81%	-21.36%	-20.13%
Q5	-21.60%	-20.30%	-22.61%	-22.24%	-25.44%	-22.39%	-21.82%	-23.32%

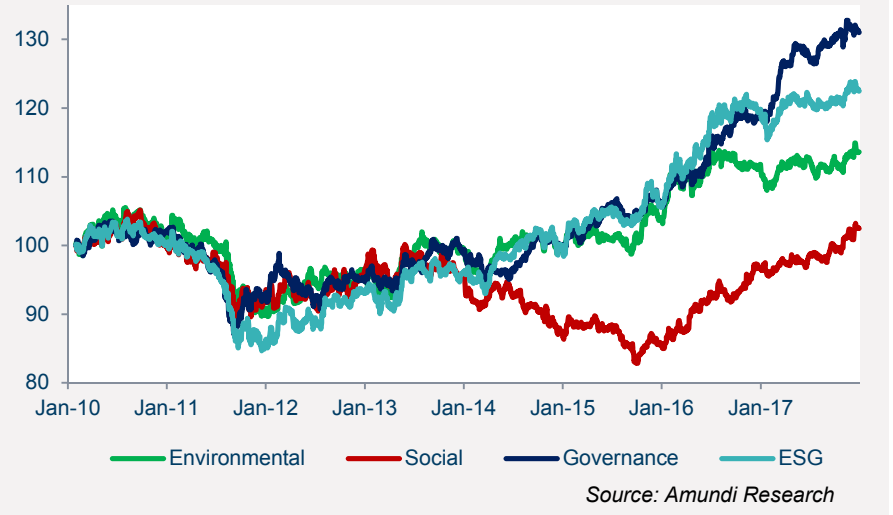
[6] *GAFA refers to Google, Amazon, Facebook and Apple.*

In the first period, drawdowns in Table 3 used to be higher for the best quintile. This also demonstrates a slight reduction of drawdowns for the best quintile compared to the lower-ranked ones over the more recent period, but differences are not significant except for the environmental pillar. This reduction in drawdowns participates in the good performance of first and second quintiles.

EMU

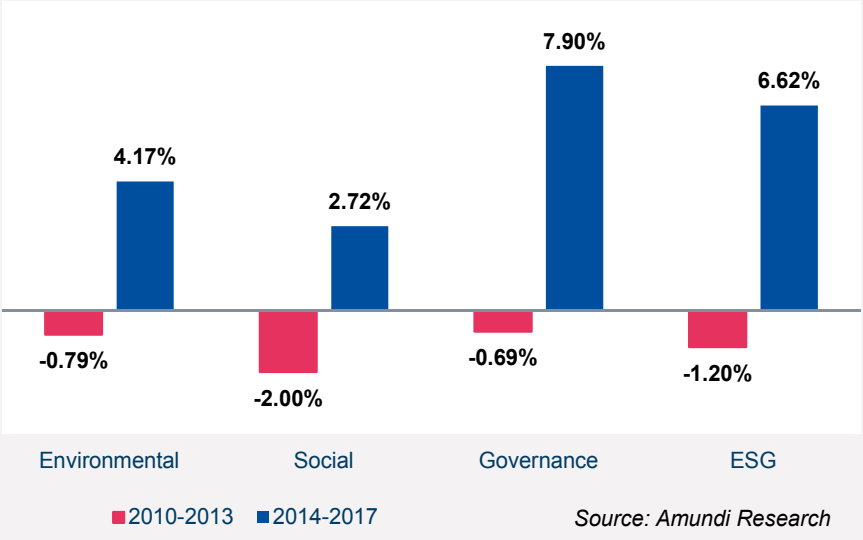
We will now focus on quintile performance distribution profiles within the Eurozone, following the same methodology to assess the scale of the outperformance entailed by the selection of best rated companies' over time. Figures 11 and 12 show that the governance pillar has been the most rewarded in the Eurozone. ESG, E, S and G integration would have led to underperformance between 2010 and 2012. Average annualized performances would have been slightly negative in the first period (Figure 12) but demonstrate consistent and impressive outperformance on the second. Indeed, buying best and shorting worst G-rated stocks generates roughly 8% absolute outperformance (Figure 12). This result implies that best-in-class clearly started to strongly outperform worst-in-class. The social pillar starts to perform since 2016 catching-up the trend of other pillars.

Figure 11: Cumulative relative performance Q1 vs. Q5 [MSCI EMU: 2010-2017]



Source: Amundi Research

Figure 12: Average annualized long shorts returns [MSCI EMU]



Source: Amundi Research

The quintile profiles in Figure 13 highlight a change in trend between the two periods. The average annualized performance between the two periods has not significantly changed. Between 2010 and 2013, both best and worst portfolios outperformed their equally weighted benchmarks, which explains the neutrality of the ESG long/short portfolios in the first period. In this case, we see quite flat profiles in the first period. From 2014 to 2017, the worst quintile was penalized and the best, clearly rewarded. The ESG first quintile did indeed reach 14.7% annualized returns, whereas the worst one's performance dropped to 7.5% between 2014 and 2017. More importantly, the last quintile is the only one that has displayed lower performance in the second period, when MSCI EMU performed relatively well, i.e., every other quintile displays better metrics. This might be caused by the increase of exclusion strategies in Europe, which led to lower valuations of poorly rated stocks. Figure 14 shows that best-in-class selection over worst-in-class doubles the Sharpe ratio in the second period.

Figure 13: ESG performance of sorted portfolios [MSCI EMU]

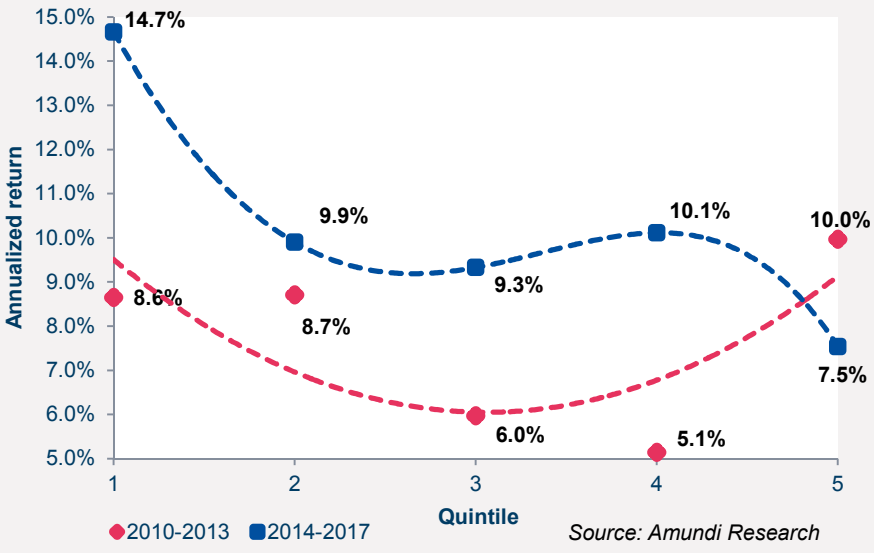
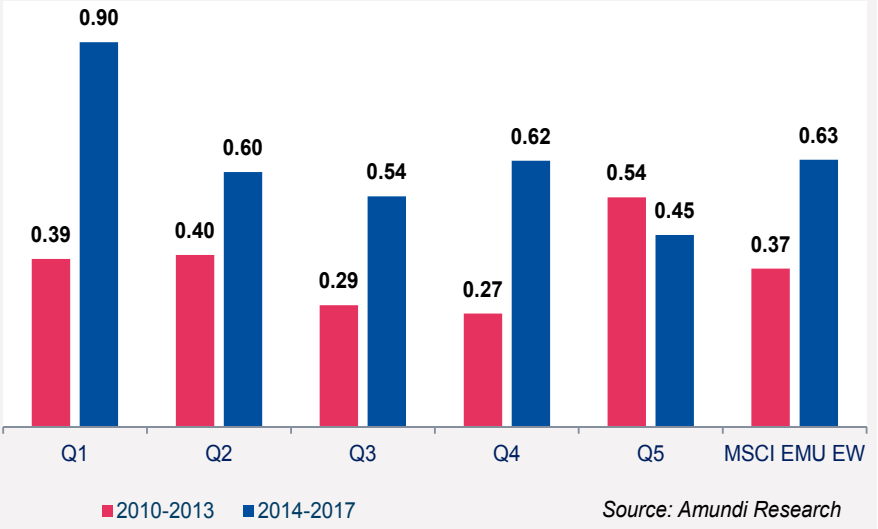
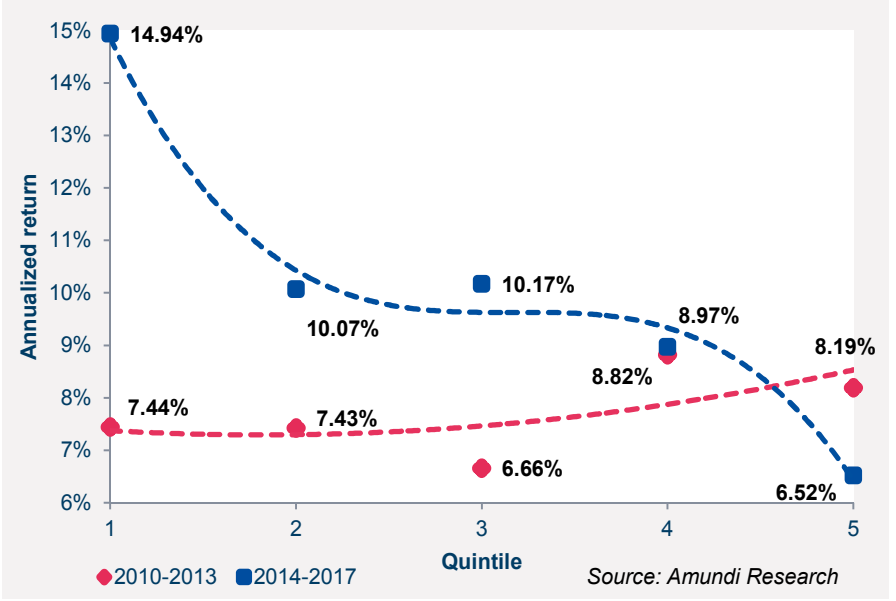


Figure 14: Sharpe ratios [MSCI EMU]



There was a clear outperformance of the governance long/short portfolio, which is confirmed by the study of quintiles (Figure 15). As we observed in ESG above, the gap between governance of best and worst portfolios widened, while the performance of the second, third and fourth quintiles were not significantly different from each other in the second period. A positive change in trend on governance quintiles drawdowns is also clear. Indeed, computing risk-adjusted returns on quintiles generated from governance pillar gives a 0.91 Sharpe ratio for the worst against 0.39 for the last (Appendix A, Figure 2).

Figure 15: Governance performance of sorted portfolios [MSCI EMU]



Environmental integration has shifted up but presented a convex profile in the first period (Figure 16). On the other hand, returns of social quintiles follow a governance-like profile to a lesser degree, slightly rewarding the best and strongly penalizing the worst, with no effect on the quintiles in between. While environmental screening presents better metrics for best-in-class, social screening seem to mostly affect the worst-in-class in this universe. If we focus in the last two-year period (2016-2017) on Figure 17, the first social quintile strongly outperformed the worst, and the gap between those two kept widening. The social pillar has the same trend as the governance pillar, but from 2016.

Figure 16: Environmental performance of sorted portfolios [MSCI EMU]

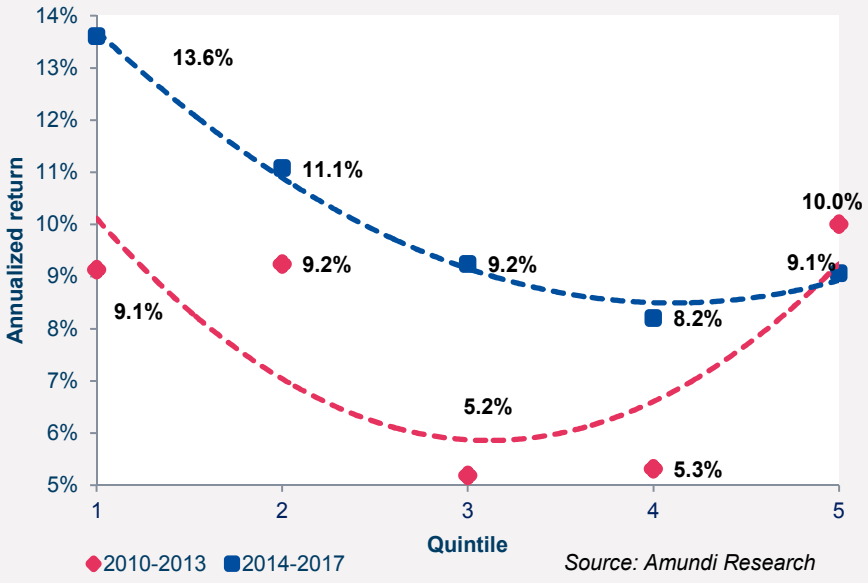
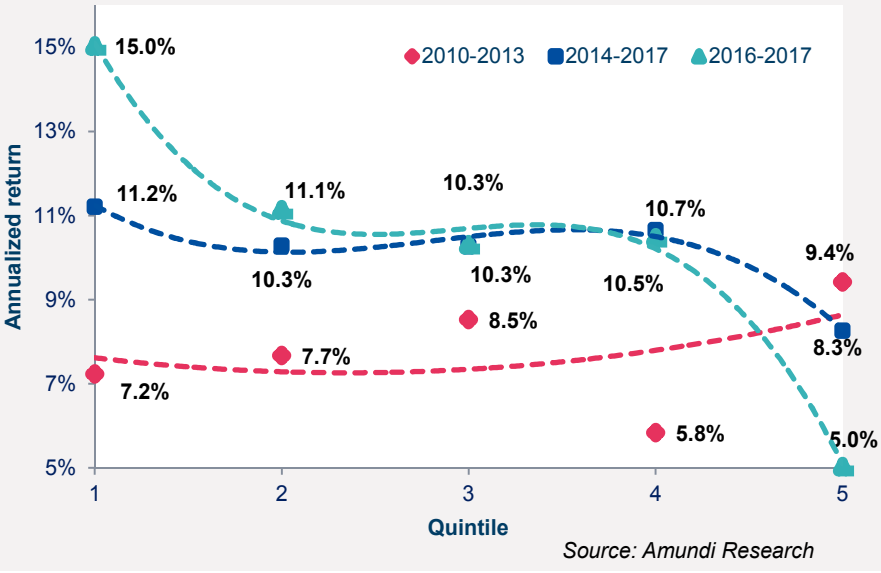


Figure 17: Social performance of sorted portfolios [MSCI EMU]



There is strong evidence that ESG investing is now rewarded in the Eurozone. The G pillar has been well integrated into prices since 2014, environmental pillar quintiles performance profile presents an encouraging trend. However, social scores seem to be incorporated in the pricing and effectively affect both first and last quintile performances since 2016.

In the Eurozone, size bias leads to overweight large caps and underweight middle capitalization in the first period. Profiles are mostly the same in the second period except for environmental and governance. Investment strategies selecting best environmental scores shift from large caps to both mid and large caps overweighting, which entails a strong positive selection effect in the second period. This period presents a mostly neutral allocation effect, which shows that outperformances are attributed to the selection of well-performing and highly rated companies within each size category. Governance selection also presents a quite different profile in the second period and slightly underweights large-caps. Selection of the best over the worst in terms of governance has lower effect on weighting, which implies that G criteria is less exposed to size bias.

Table 4: Sorted portfolios drawdowns

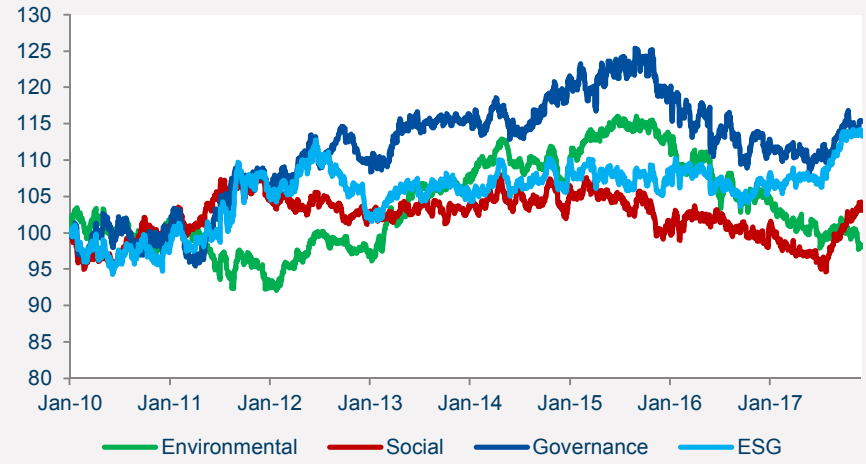
	ESG		Environmental		Social		Governance	
	2010-2013	2014-2017	2010-2013	2014-2017	2010-2013	2014-2017	2010-2013	2014-2017
Q1	-36.28%	-20.58%	-36.20%	-26.43%	-33.78%	-25.60%	-36.32%	-21.64%
Q2	-34.42%	-26.55%	-32.71%	-23.54%	-33.03%	-27.12%	-33.23%	-22.19%
Q3	-31.85%	-27.11%	-32.58%	-27.74%	-31.51%	-28.28%	-35.30%	-27.25%
Q4	-33.61%	-26.88%	-34.32%	-30.20%	-36.18%	-22.90%	-27.31%	-29.87%
Q5	-26.36%	-25.89%	-27.74%	-26.43%	-28.56%	-23.99%	-30.17%	-26.68%

In the first period, higher scores entailed higher drawdowns. In the second one, while Table 4 shows a clear reduction of drawdowns implied by the increase of governance and ESG scores

Europe ex-EMU

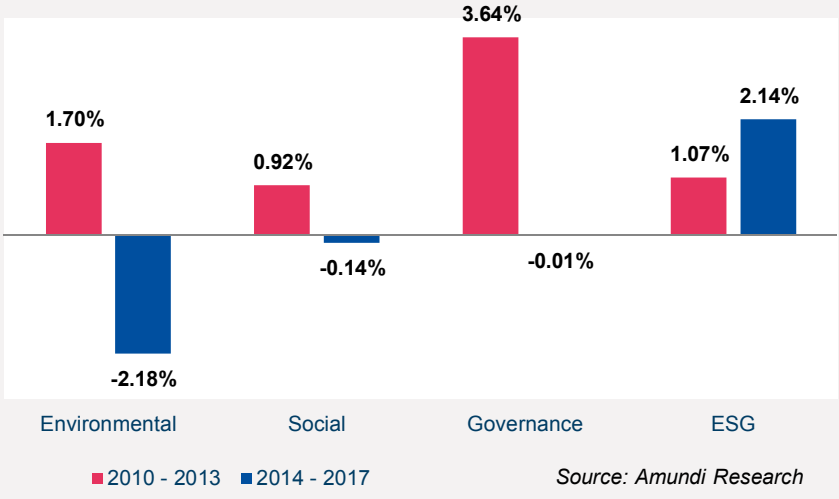
In contrast to the Eurozone, where the results were explicit, this study does not lead to conclusive returns distribution between quintiles (Figures 3 to 6 in Appendix A), due to the different integration of each extra-financial pillar in each country.

Figure 18: Relative performance Q1 vs. Q5 [MSCI EUROPE EX-EMU: 2010 - 2017]



Source: Amundi Research

Figure 19: Average annualized long shorts returns [MSCI EUROPE EX-EMU]



Source: Amundi Research

In Figure 18, the social long/short portfolio is neutral over the full period. The environmental portfolio used to provide slightly positive excess returns but these dropped considerably in July 2015. The governance pillar leads

to an outperformance between 2011 and early 2016 but also dropped late in the period. However, the ESG long/short portfolio created from best and worst quintiles in terms of aggregated ESG global scores provides stable average annualized returns of roughly 1.5%, which shows that a best-in-class selection according to the global score would have been more efficient on this universe (Figure 19).

The ESG investment process slightly outperforms over the full period. This outperformance is mostly due to the selection of well performing large caps in the second period. Size allocation effects on performance are neutral for the global score. The same performance attribution shows that selecting stocks with higher environmental scores overweights large cap companies. In this case, this creates a positive selection effect on excess return that balance the underperformance due to the negative one on small and mid-caps over the first period. However, between 2014 and 2017, allocation and selection effect on large caps does not balance the underperformance caused by negative size selection effect on both middle and large caps. Social pillar seems to be partly explained by a size effect as its performance is driven by the selection of large caps and mid-caps that are overweighted respectively underweighted on both periods. Concerning governance, there is change in weightings between the two periods. The mid-caps were slightly overweighted in the first period while they are underweighted on the second one but changes in weightings are less significant that they are for other scores.

Table 5: Relative country weight of Q1 vs. Q5

	ESG	E	S	G
Denmark	1.90	0.60	0.21	-13.73
Norway	5.13	2.99	6.43	-3.95
Sweden	9.06	9.93	26.54	-17.36
Switzerland	-29.36	-5.40	-25.21	-25.49
United Kingdom	13.36	-8.68	-8.15	60.32

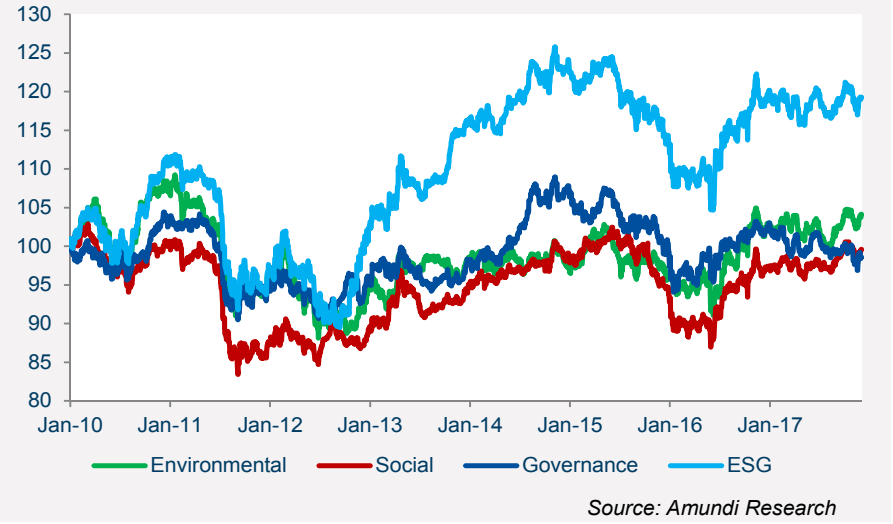
However, the inconsistency of performance attributions related to pillars does not allow further assumptions on their respective pricing. One can also note that this universe is biased by currency and many other macro-economic events, such as Brexit or Swiss bank policies, which explains why results hardly provide any quantitatively interpretable information. Relative country weights of Q1 vs. Q5 in Table 5 revealed that ESG leads to strongly underweighting Switzerland, which can have both a slightly negative allocation and currency effect. Environmental scores used to overweight Sweden and United Kingdom between 2010 and 2014 have partly shifted to a negative allocation of the UK in favor of Norway, with negligible currency

effects, on average. The social profile is very similar, with an even stronger allocation in Sweden in the second period. Governance drives the strategy to focus on the UK, which generated strong negative allocation and currency effects in the second period. The Brexit announcement could partly explain the overall negative currency effect but not the underperformance of the governance long/short portfolio between 2015 and 2017. On the other hand, the selection of the best-in-class in terms of governance makes it possible, on average, to balance them both.

Japan

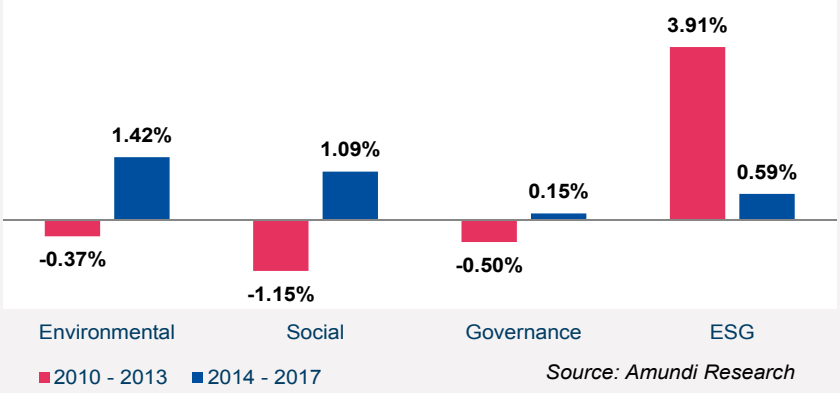
Japanese companies have low governance scores compared to North American and European stocks. For example, the worst-in-class quintile of the unconstrained MSCI World Index contains 67% of Japanese companies. However, this is no basis for concluding whether or not governance relative rankings within Japanese index can be a source of alpha or differentiation. The current Japanese prime minister, Shinzo Abe, and his government have led structural reforms centered on corporate governance to revitalize the country's economy. Improving governance then became a government policy and not only a corporate goal. The idea of this so-called third arrow of the Abenomics is that improving corporate governance will make executives focus on profits and productivity. Figures 20 and 21 show, however, no sign of a specific reward of governance pillar, which can raise the issue of the effect on the reforms in the pricing of Japanese equity market of better governance.

Figure 20: Relative performance Q1 vs. Q5
[MSCI Japan: 2010 - 2017]



Source: Amundi Research

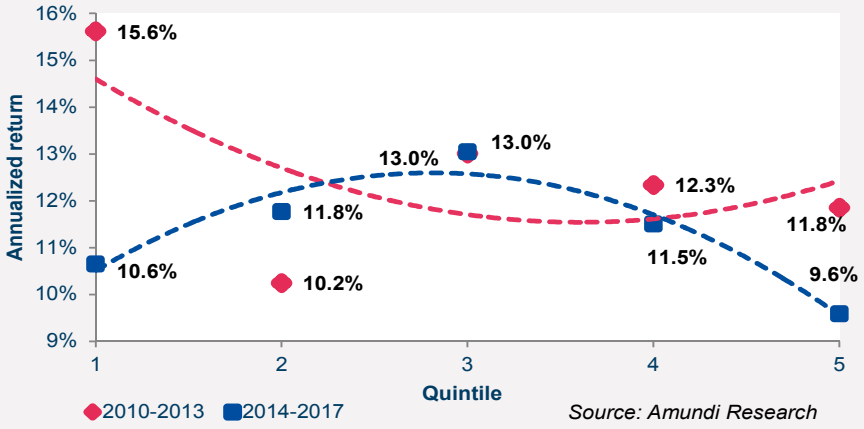
Figure 21: Average annualized long shorts returns [MSCI Japan]



Source: Amundi Research

Figure 20 shows that E, S and G long/short portfolios are neutral over the full period. They mostly underperformed in late 2011 and followed a quite erratic growth until the next drop, in 2016. ESG selection shows higher returns, especially between 2013 and 2015. This shows that selection according to a score "qualitatively weighted" can to some extent outperform the portfolio based on E, S and G criteria. In Japan, differences in weightings (Appendix A, Figure 7), from market cap weighted to equally weighted, generate different results. Indeed, by building a market cap-weighted portfolio we note that the worst quintile strongly underperforms. Figure 22 shows that both best and worst quintiles' securities prices have severely dropped in the second period while the "middle class" ones kept their returns stable.

Figure 22: ESG performance of sorted portfolios [MSCI Japan]



Source: Amundi Research

Unlike in the Eurozone and North America, there has been no integration of ESG in Japan, according to this study. Both best and worst quintile underperformed in the second period. The highest performance is obtained by the third quintile, demonstrating a concave relationship in ESG integration in Japan. ESG long/short portfolio performance in Figure 26 is mostly explained by outperformance of the first quintile between 2013 and 2014.

Governance is neutral in the second period. For environmental and social pillars the third quintiles are the most rewarded (Figures 8 to 10 in Appendix A)

Japan ESG investing generally underweights small and mid-caps and overweights large caps. There is no size allocation effect entailed by this change in weightings. However, there are varying or neutral selection effects on the different size categories over the different periods. This inconsistency lead to neutral results overall. The best performance was obtained by ESG long/short portfolio in the first period, whose performance was driven by selection effect of both small and large caps.

3.2.2. From global indifference to broader integration

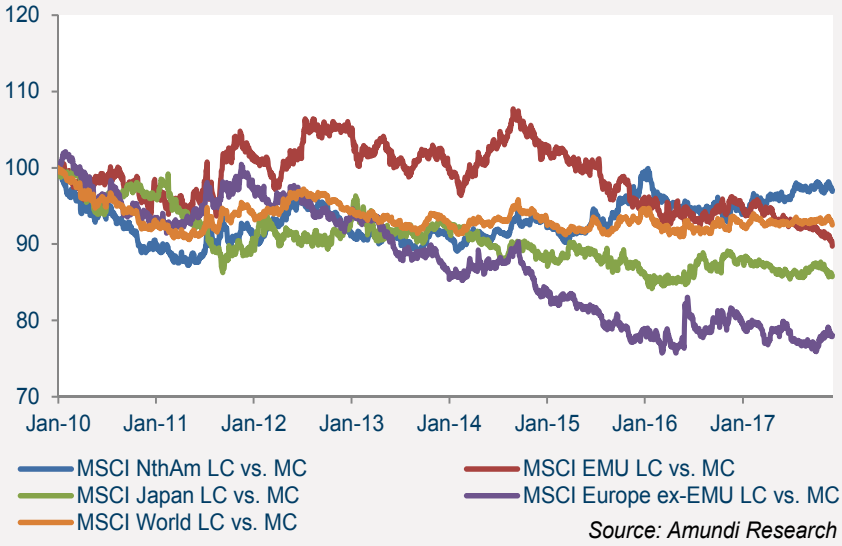
Extra-financial criteria reward has varied over time and from region to region. This part focuses on the effect of ESG selection; i.e., as a source of alpha. We demonstrate that there has been a substantial change in trend in North America. Sector-neutral environmental best quintile provides the best results with, however, a strong size bias overweighting large caps. Governance has had no size bias or positive outperformance since 2016. GAFA companies belong to the fourth or last ESG quintile, so they do not impact the outperformance of the first quintile in the recent period but may explain ESG long/shorts portfolio neutrality in the first one. In the Eurozone, selection of the best over the worst using any pillar outperformed in the recent period. Sector-neutral governance best quintiles display the best metrics with better risk-adjusted returns and almost no size bias implied by its construction. Worst-in-class quintiles are also negatively affected. Social long/short portfolio performance had the same trend as the governmental one but delayed to early 2016. However, it does mark a steeper ascent over the two last years.

Overall, the selection of large caps over mid-caps generated some outperformance between 2014 and 2017, while mid-caps globally tended to outperform large caps (Figure 23), underlying the strong positive selection effect of ESG filters despite its remaining biases. Size bias is therefore influential but is not necessarily the source of performance. From another angle, following a reasoning similar to Campbell's (2007) with a more qualitative and causal analysis[7], we would probably conclude that firms having a large market capitalization and anticipating regulatory

[7] *In other terms, a non-portfolio study*

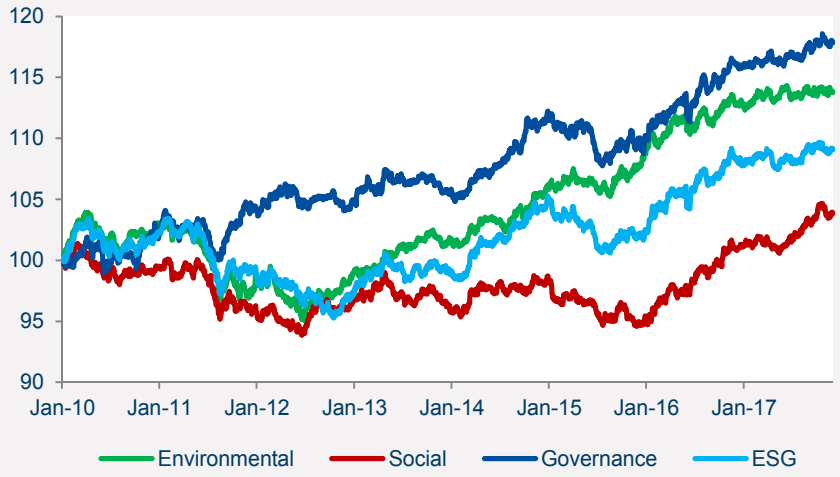
measures are likely to behave in a more responsible way, while middle and small capitalization companies might not have the financial means to do so. From a portfolio construction perspective, further time specific attribution studies are required to evaluate size factor's influence on each specific ESG integration strategy performance.

Figure 23:
Large cap vs. mid-cap indices



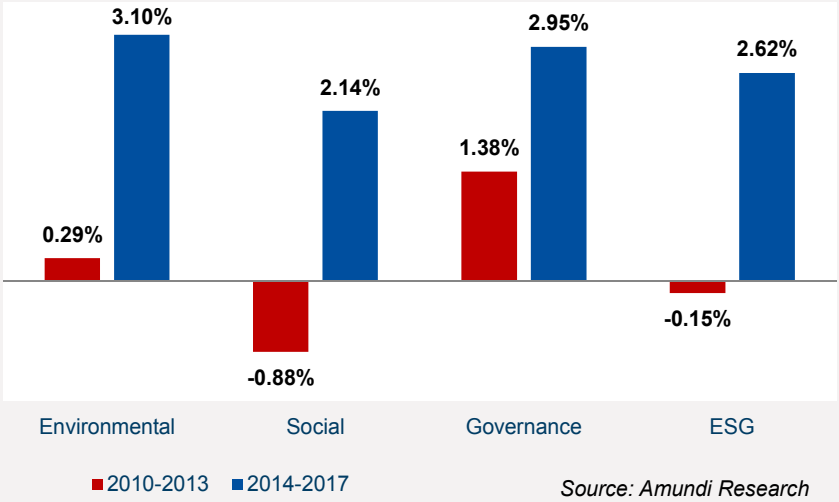
The rating methodology does not neutralize geographic bias, as belonging to a geographic area is not an excuse for ignoring ESG criteria. To eliminate most of the biases that can be created in a global universe, we built quintiles that were both region and sector-neutral. Without a regional neutrality constraint, the first quintile would focus on the European zone, which would be overweighted by, on average, 40%, while North America and Japan would be underweighted by 20% vs. the MSCI World Equally Weighted Index. These figures may vary according to each E, S and G criterion and over time. As these portfolios were constrained to be both sector- and region-neutral with a negligible currency effect, the outperformance is explained by the selection of the best-performing securities within each region and each sector. Figures 24 and 25 reflect the integration of extra-financial scores on the MSCI World Index universe.

Figure 24: Average annualized long shorts returns [MSCI World Index : 2010 – 2017]



Source: Amundi Research

Figure 25: Average annualized long shorts returns [MSCI World Index]



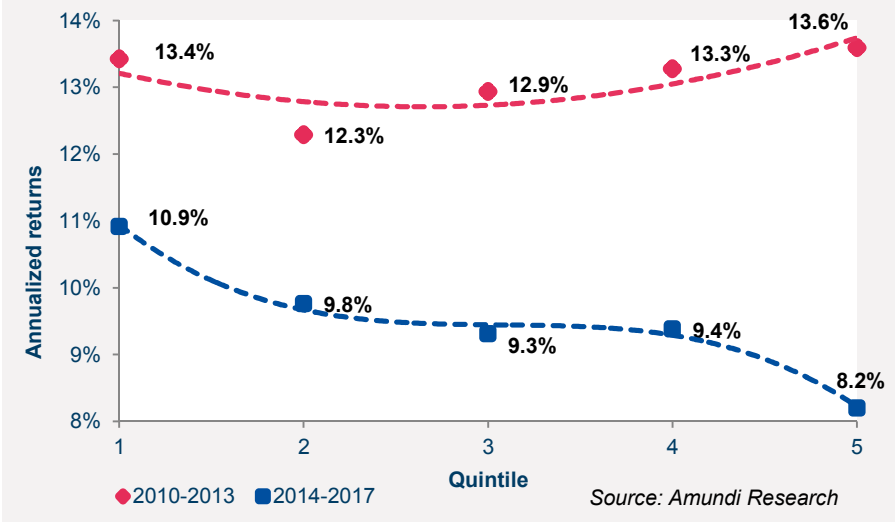
Source: Amundi Research

Over the whole period, the governance pillar almost constantly outperformed, which is in line with the literature. Gompers *et al.* (2003) shown that there

was a correlation between high governance[8] and stock returns in the 1990s. They failed, however, to demonstrate the potential causations. The United Nations Environment Programme Finance Initiative Asset Management Working Group and Mercer, LLC. (2007) highlighted the fact that the period included the tech boom, which might impact the results. However, Figure 26 offers no evidence of integration of any of the extra-financial signals before mid-2011, when governance started to perform. ESG and S long/short portfolios underperformed slightly between 2010 and 2013, and environmental portfolios showed neutral performances from 2010 to 2013. More specifically, there has been a growing trend common to ESG, E and G starting late 2012, while social remained neutral until 2015, when it began to track the global ESG trend. This is in line with regional observations. Environmental long/short portfolios have been the least affected by the Chinese crisis because of its robustness in North America. The global social trend tracks the European trend with a steep increase since January 2016.

The non-linear relationships expressed by the curves (Figures 26 to 29) can call into question the significance of the causal relationship between good practices and returns that would be characterized by a progressive increase of the performance with the level of engagement. The effect of extra-financial concerns is more likely related to the mismatch of supply and demand for ESG well rated companies particularly mentioned by Galema *et al.* (2008).

Figure 26: ESG performance of sorted portfolios [MSCI World Index]



[8] *Governance in this study was restricted to shareholder rights.*

Figure 27: E performance of sorted portfolios [MSCI World Index]

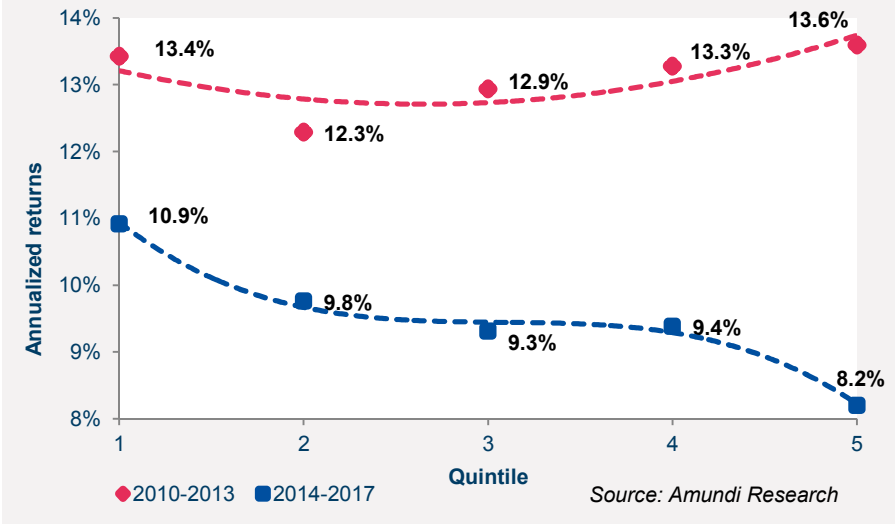


Figure 28: S performance of sorted portfolios [MSCI World Index]

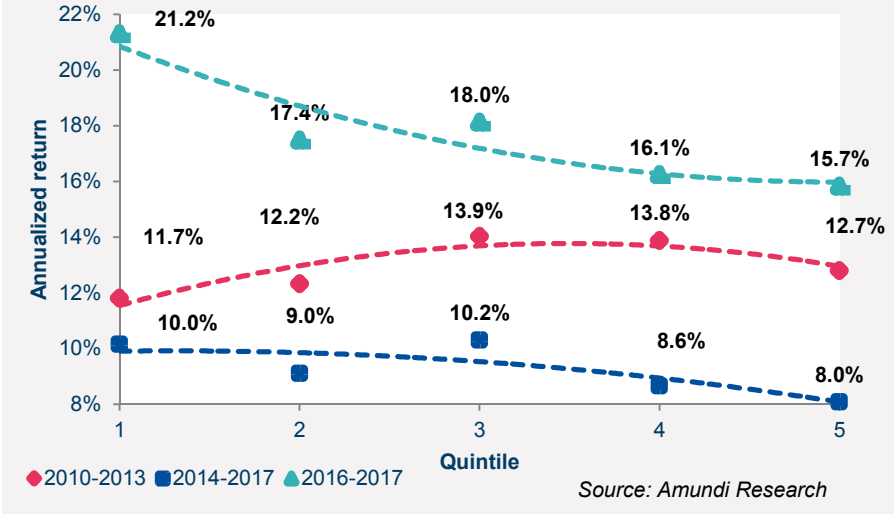
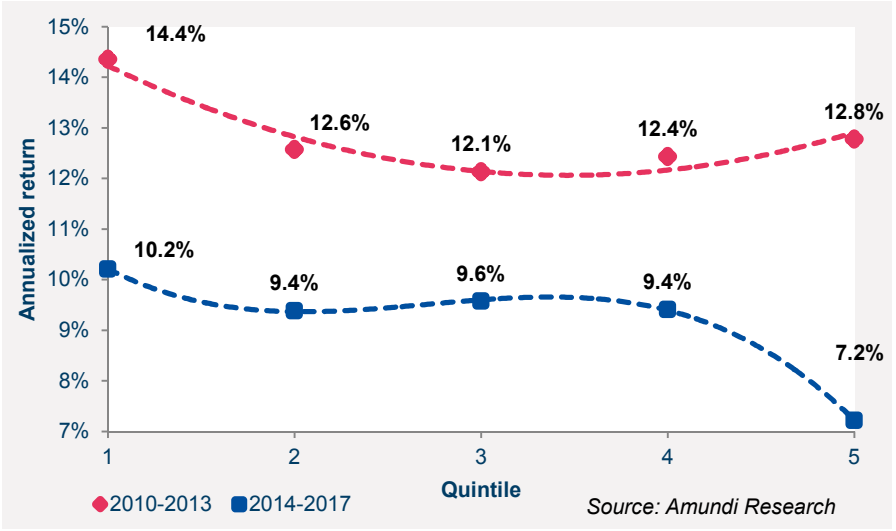


Figure 29: G performance of sorted portfolios [MSCI World Index]



There is a common trend to every score. In the first period, the neutral profiles show no evidence of an ESG premium. The governance criteria were, however, already rewarded in the first period (Figure 29). There are generally no significant differences between quintiles between 2010 and 2014, which is in accordance with the results of our previous study, demonstrating that ESG was at that time, a free option to exert one's moral values with no concrete integration in prices. It might also recall the results of Barnett and Salomon (2006), who demonstrated a curvilinear relationship – a U-shaped profile – between screening intensity and risk-adjusted performance. Results, however, varied as a function of the variable used in the screening process. In this case, we observe quite flat profiles in the first period, but the MSCI EMU presented this type of U-shaped profile.

The shape of these curves shows that, despite the overall reduction of average global returns between 2014 and 2017, the market seems to have better integrated extra-financial information. Indeed, the first quintile is clearly rewarded, while the last one is depreciated.

A decomposition of the social signal would be necessary to understand which specific criteria caused the negative influence over the first period and which are the ones clearly priced on the second. However, this result is in line with other previous studies, Geczy *et al.* (2003), for example, have shown that social screening had a cost in performance that depends on

investors beliefs[9]. From a managerial point of view, social responsibility was often seen, in some cases, as a limiting factor of the financial efficiency. In this case, we show that a best-in-class selection according to the social pillar used to have a cost in terms of performance, as indicated by the profile in the first period, as it had not received yet the benefits of increasing demand from investors. However, there is a substantial and general change in trend (Figure 28), and the integration of this score seem to be delayed compared to other pillars.

In a global universe, quintiles 2, 3 and 4 are not appreciably affected, and the discrimination is mostly between best and worst-in-class, as best-in-class has been rewarded and worst-in-class penalized. This quintiles study showed a varying effect of ESG selection. We will now focus on the impact of ESG constraint in index-based portfolio construction on risk metrics and returns.

3.3. ESG tilted-up indexes, impact on risk and return

One of the most common approaches of ESG integration in practice, particularly used by index portfolio managers, is to progressively increase the global score of a portfolio to investigate the impact of maximizing ESG profile on risk metrics and performance. This methodology was applied to the MSCI World Index, MSCI North America, MSCI Europe and MSCI Japan, to highlight geographical specificities. Unlike the payoff study, we have not distinguished Europe EMU and ex-EMU in this part, to avoid country bias occurring out of the Eurozone when using ESG because of the large disparities between Europe ex-EMU countries. Extra-financial distribution tends to present less disparity in this aggregated index despite the slight currency effects introduced. Again, we focused on different time periods searching for potential change in trends between 2010 and 2017, with a quarterly reallocation frequency. The excess global ESG score of each index has been progressively increased, starting from a 0.1 enhancement to reach an extreme 1.5 upgrade level. To stay in a more common case of use ESG tilt on benchmarks, we will focus the performance study on tilts from 0.1 to 0.9, i.e., 1 and 1.5 are indicative. Portfolio optimizations were performed with a multi-factor risk model targeting the desired ESG score and minimizing the tracking error vs. the parent index. The optimized portfolios obtained do not generate significant sector or regional bias (Appendix A, Figure 11 and 12).

We consider the following optimization function[10]:

$$x^*(\gamma) = \arg\min \frac{1}{2}\sigma^2(x|b) - \gamma s(x|b)$$

[9] *If investors believe in the CAPM, then the cost of social screening is low – at 1, 2 basis point per month – but if investors believe in multi-factor models and manager skill, performance costs then go up to 30 basis point, according to the authors.*

[10] *We note* b *the benchmark,* s *the vector of scores and* Σ *the covariance matrix.*

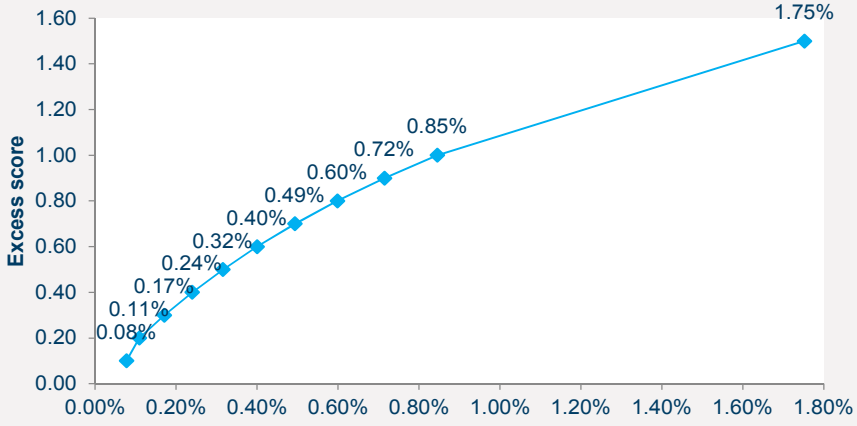
where $\sigma(x|b)$ is the ex-ante tracking (TE) of portfolio x with respect to the benchmark b equal to $\sqrt{(x-b)^T\Sigma(x-b)}$ and $s(x|b)$ is the excess score of the portfolio x with respect to the benchmark.

3.3.1. Tracking errors and drawdowns analysis

This approach overweights securities with higher ESG scores and underweights securities with lower scores without excluding them straight away. In other terms, the more we maximize the global ESG score, the more we focus on a smaller range of securities, the ones with the highest scores. This methodology entails a progressive exclusion of some of the worst securities in terms of ESG and shows the effect of extra-financial excess scores. This work represents to some extent a follow-up of the previous part, as the worst quintile portfolio is mostly composed of the securities that are excluded by higher tilts. The increase of the excess ESG score from 0.1 to 1.5 on the MSCI World Index leads to an increase of the ex-ante tracking error (TE) from 8 bps to 175 bps, as shown by the efficient frontier (Figure 30). The confidence intervals are also widening with the tilt, which demonstrates a larger spread of the tracking error around its average value (Figure 11 in Appendix A). Efficient curves present the same profile on every universe. The decomposition of the tracking error between the E, S and G scores provides more information about the source of risks (Figure 31). Governance has a higher contribution to tracking error because this score presents lower correlations, on average 25% with E and S, while E and S are correlated at 71.4%. G sub-criteria[11] also present low correlations. For example: to improve the portfolio excess score of 0.9, we observe a tracking for the social criteria of 66 bps, for the environmental pillar of 68 bps and for the governance pillar of 124 bps while the tracking error for the ESG global score is 72 bps.

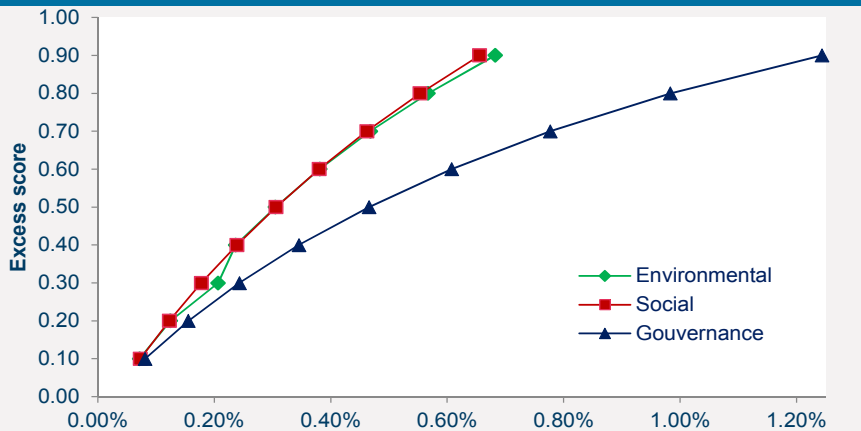
[11] *For example, ethics, board structure, shareholder rights are less correlated with one other than environmental and social engagement.*

Figure 30:
ESG efficient frontier



Source: Amundi Research

Figure 31:
Extra-financial efficient frontiers

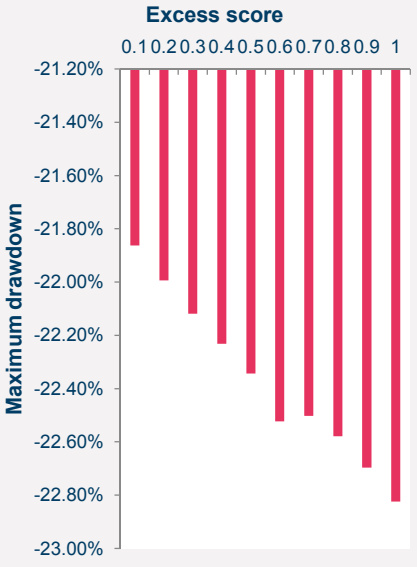


Source: Amundi Research

Drawdown measure is commonly used to assess the maximum loss over a period. We studied the change in this metric on the tilted portfolios. From 2010 to 2013, tilting to some extent progressively increased drawdowns along with excess scores. However, results have shown that a tilt of 1 of the ESG score has no impact on ex-post volatility, which varies from 13.41% to 13.59% over the full period.

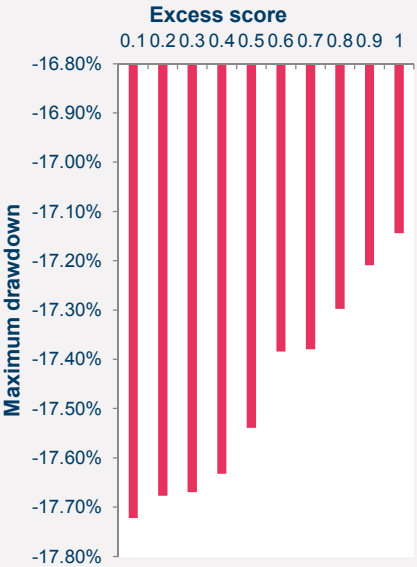
Focusing on the last four years, we observe, on the contrary, a slight reduction in the drawdowns implied by the increase in the ESG score. The scale of the reductions of the absolute drawdowns is not significant, but it is notable that the ESG constraint's effect on drawdowns shifted from negative to positive. This observation can be made on every ESG pillar and confirms that ESG can be considered as a way to prevent drawdown risks. Indeed, as shown in Figures 32 and 33, for an excess ESG score of 1, maximum drawdown has evolved from an increase by roughly 1% to a slight reduction by 0.6%, provides encouraging evidence advocating the use of ESG signal in investment processes.

Figure 32: Maximum drawdowns [MSCI World Index: 2010 - 2013]



Source: Amundi Research

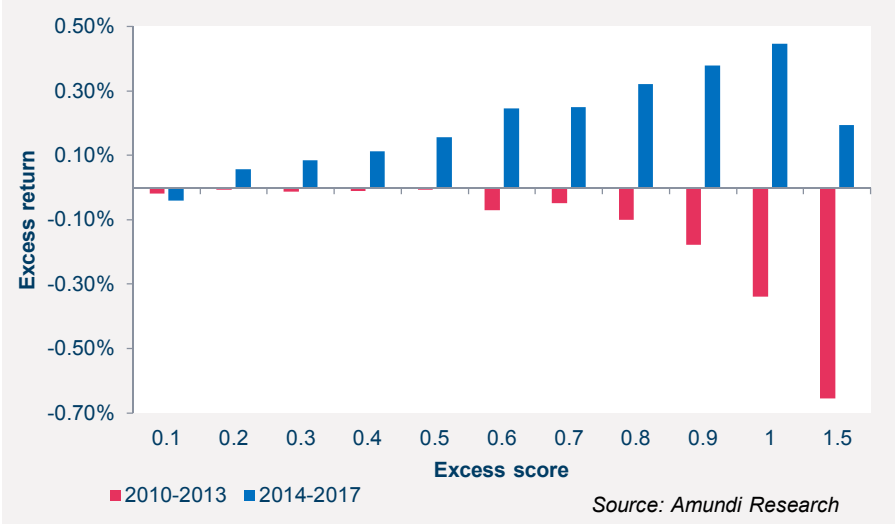
Figure 33: Maximum drawdowns [MSCI World Index: 2014 - 2017]



Source: Amundi Research

ESG integration by tilting indexes has an increasingly positive effect on both performances and slight drawdowns reduction with a very limited and quite stable tracking error overtime implying a slight increase of information ratios. Figure 34 shows that, even in the second period, tilting indexes over roughly one standard deviation was detrimental to the excess performance. Indeed, a study by Statman and Glushkov (2009) showed that if tilting portfolios toward high-ranked securities was beneficial, shunning "sin stocks" has a negative impact offsetting the advantage of tilting. To avoid these negative effects, the coming tilt studies will be limited to a tilt of 0.9.

Figure 34: Annualized excess return [MSCI World Index]

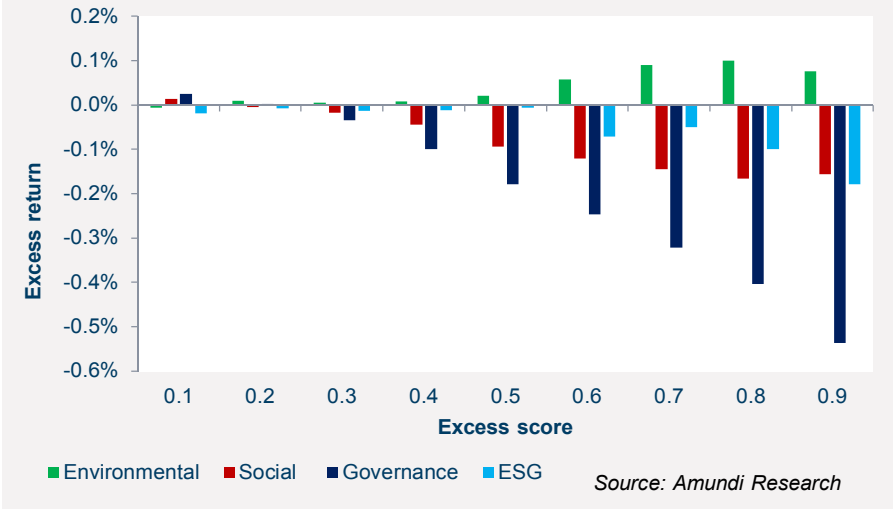


3.3.2. Excess return with excess score?

Increasing the ESG score of the MSCI World Index progressively demonstrates a slight underperformance, between 2010 and 2013. However, the trend has positively evolved over the last decade, and this former observation does not apply in more recent periods, when the relationship between ESG score and performance has progressively shifted up. An environmental tilt has produced positive excess returns since December 2011 and governance tilted portfolio underperformed until October 2012 but showed a steep increase after that. Social criteria were still unpriced in the whole period, but this pillar shows a steep increase since July 2015.

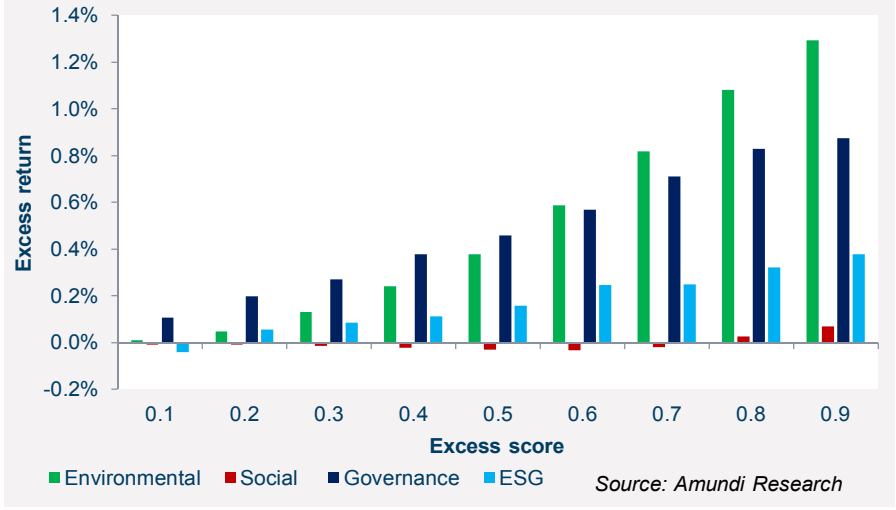
Figures 35 and 36 sum up these conclusions displaying the average annualized excess returns over the two focus periods of each tilted portfolio. It confirms that portfolios tilted according to social scores produce more erratic results and are negative or neutral overall. However, the positive change in the trend can be observed on each pillar.

Figure 35: Average annualized excess returns [MSCI World Index : 2010 -2013]



Source: Amundi Research

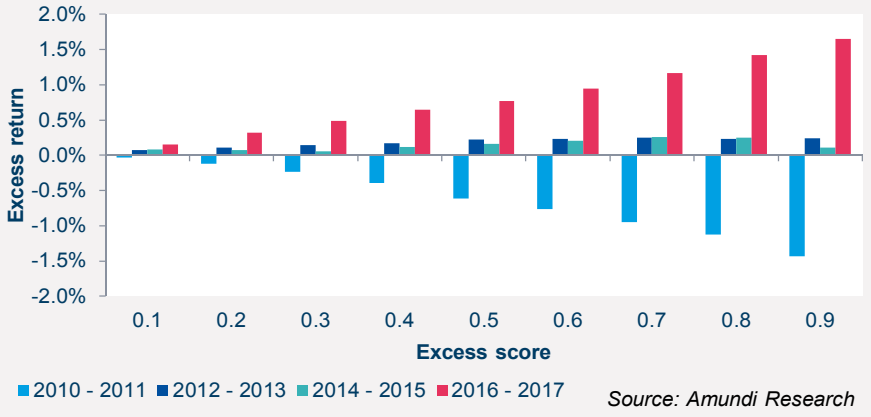
Figure 36: Average annualized excess return [MSCI World Index : 2014 -2017]



Source: Amundi Research

The governance pillar provides higher annualized excess returns, and the change in trend is more pronounced, reaching 165 bps between 2016 and 2017. Figure 37 shows that the negative influence of best governance stock-picking disappears when we focus on the most recent years.

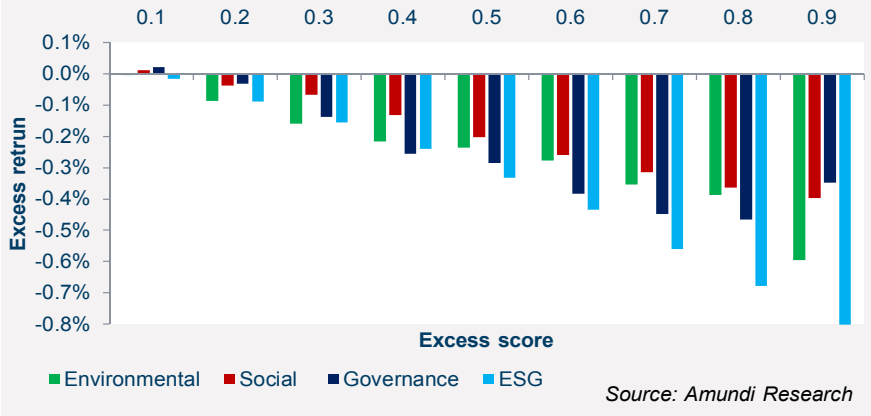
Figure 37: Rolling average excess return different periods [G tilt MSCI World Index]



Source: Amundi Research

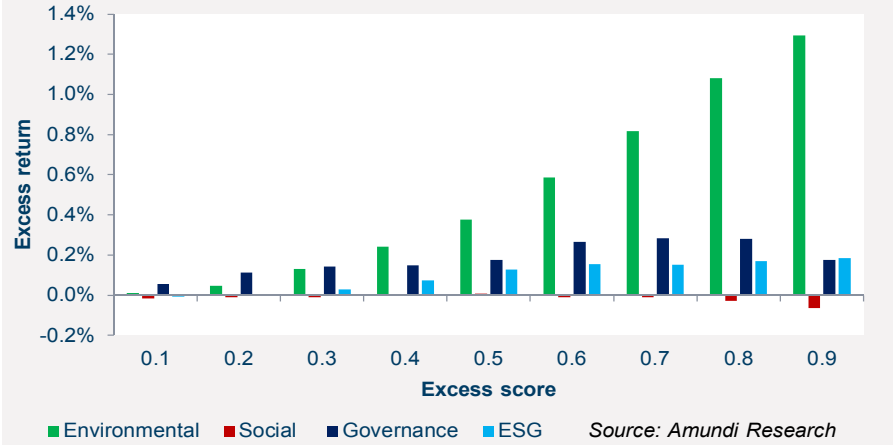
The MSCI North America Index has been tilted using the same methodology. On average between 2010 and 2013, we would have progressively generated negative excess returns while increasing the ESG scores (Figure 38). Restricting the study to shorter periods drastically improves the results. Between 2016 and 2017, the annualized average excess returns over the two years of a 0.9 ESG tilted portfolio went up to 0.72%. In term of E, S and G pillars, we observe a quite low, but increasing integration of the G score in North America with a higher reward toward high environmental scores since 2014 (Figure 39), with a steep increase on the last two years. Indeed, the 0.9 tilted portfolio provided 2.39% of average annualized excess returns over the last two years (2016-2017), leading to an Information ratio of 3.07.

Figure 38: Average annualized excess return [MSCI North America Index : 2010 -2013]



Source: Amundi Research

Figure 39: Average annualized excess return [MSCI North America Index: 2014 -2017]



On the MSCI Europe Index, average excess returns with the ESG tilt were negative, -1.42% with a tilt of 0.9, in 2010-2013 (Figure 40). However, in the shorter periods they have evolved clearly positively to reach 0.66% on average between 2014 and 2017, and 1.04% on 2016-2017 with the same tilt of 0.9 (Figure 41). The governance pillar provides increasing annualized average excess returns, reaching 3.12% between 2016 and 2017, unlike the environmental pillar, which declined slightly in the more recent period in this region but still provided positive excess returns.

Figure 40: Average annualized excess returns [MSCI Europe Index : 2010 -2013]

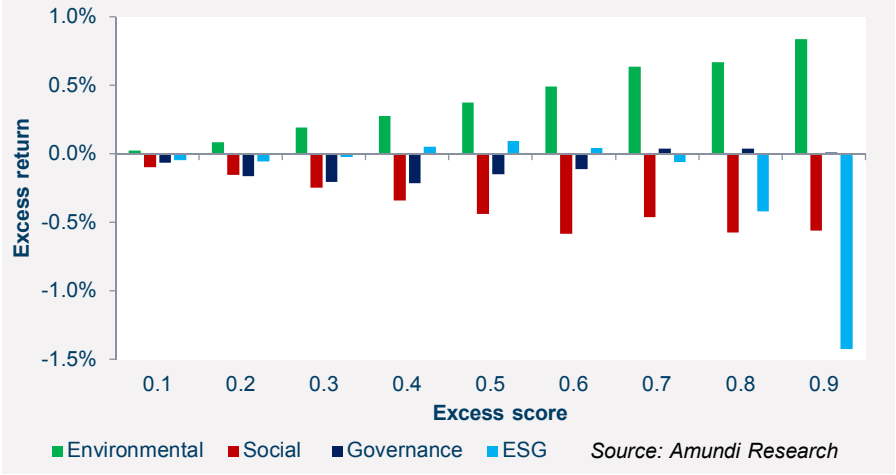
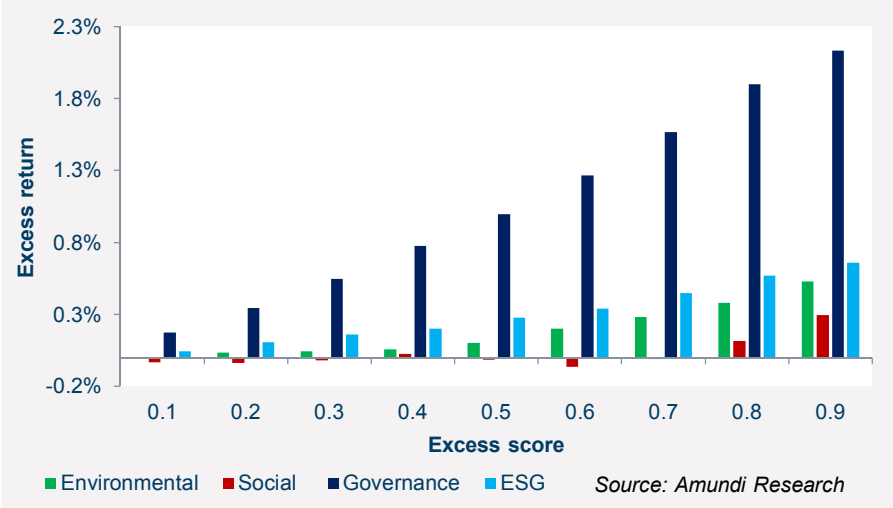


Figure 41: Average annualized excess returns [MSCI Europe Index : 2014 -2017]



In Japan, the impact of ESG investing is positive in the first period, especially for the global ESG score, while for the governance pillar, a higher score implies a negative excess return (Figure 42). In the second period, we highlight a quite neutral impact for the ESG and S components, a negative impact on the environmental pillar, and a strong improvement of excess return for the governance pillar, which reaches a 1.91% annualized excess return for an excess score of 0.9 (Figure 43). This strong impact is due mostly to the takeoff caused by Abenomics, which has involved many corporate reforms and initiatives, such as the implementation of the Japan's Stewardship Code and Corporate Governance Code, aimed at reinforcing Japan's economy and stressing governance issues. Despite the regulations, several corporate governance scandals have broken out in Japan in recent years. However, some of these results contradict those obtained with the active management process. It is difficult to draw conclusions in Japan, as results depend on the weighting schemes we have set.

Figure 42: Average annualized excess returns [MSCI Japan Index : 2010 -2013]

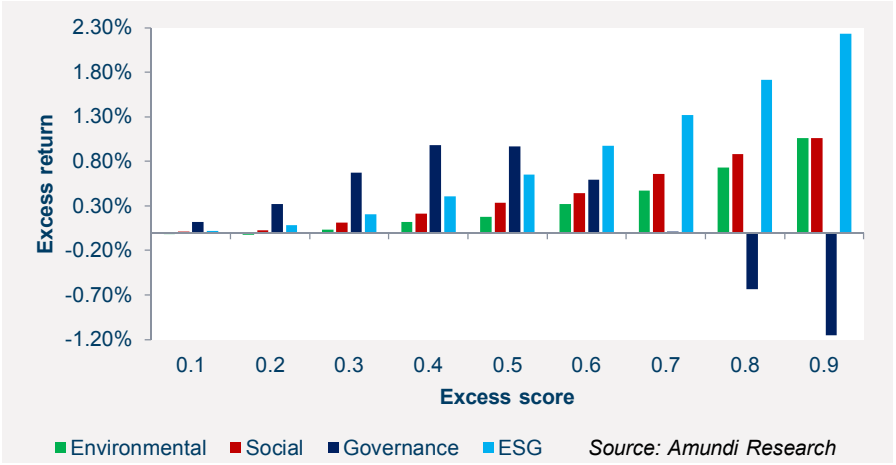
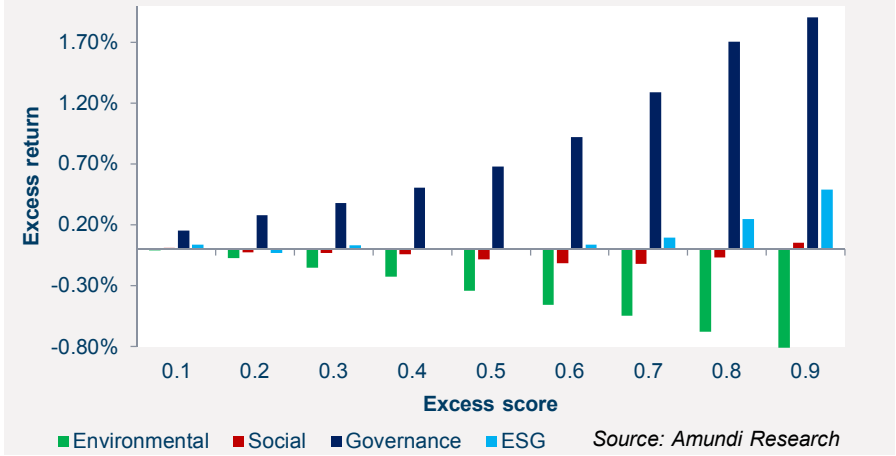


Figure 43: Average annualized excess returns [MSCI Japan Index : 2014 -2017]



IV. ESG and factor investing

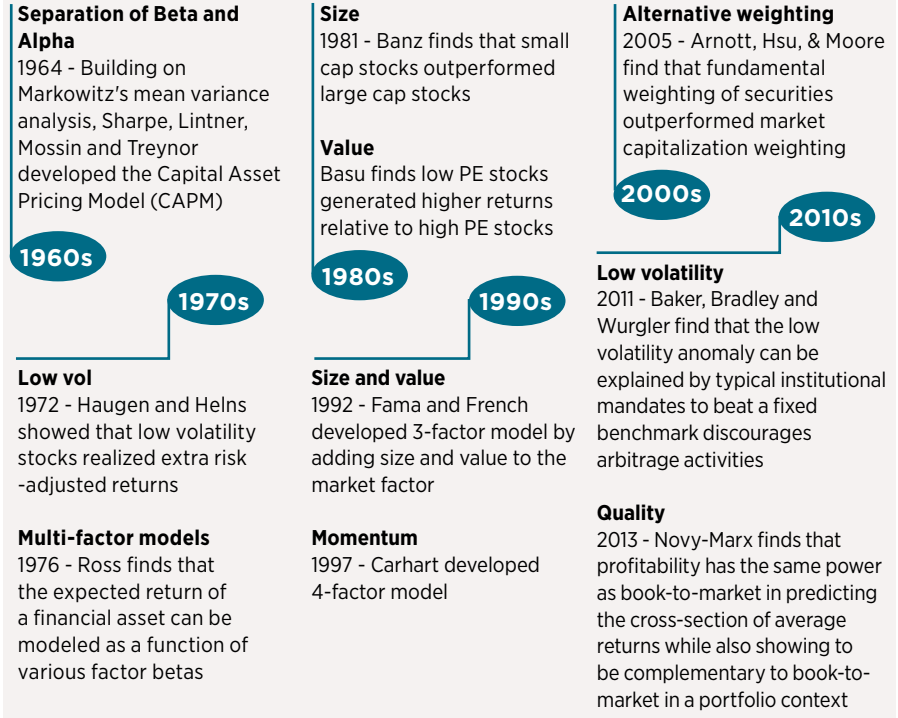
Among the different ESG strategies (see Figure 2), it appears that ESG integration is the most suited to be quantitatively integrated in a multi-factor framework. We previously demonstrated that tilting any benchmark is increasingly likely to deliver outperformance. We also deduced that the best quintile in terms of ESG recently tends to deliver some significant outperformance. The question is now whether creating an ESG factor would

be relevant and to what extent ESG quintiles outperformances are explained with the existing style factors.

4.1. Traditional approach of factor investing

As shown in Figure 44, asset pricing models evolved from the Capital Asset Pricing Model, described by Sharpe (1964), to Fama and French's (1992) three-factor model adding size (SMB) and value (HML), and to Carhart's four-factor model (1997) with the insertion of momentum (WML). More recently, Baker et al. (2011) and Novy Marx (2013) expanded the existing framework adding respectively the low volatility (VOL) and the quality (QMJ) factors. Therefore equity factor investing strategies are based on exposure to some rewarded equity factors. According to Cazalet and Roncalli (2014), risk factor investing is defined as an attempt to capture systematic risk premia. The financial metrics such as ROE, book-to-price, dividend or earnings yield are channeled to financial pricing models by the construction of time series, driven by the performances of the best ranked according to these metrics. Analogically, ESG factor would be represented by the performance of best-in-class in term of ESG.

Figure 44:
Change in factorial pricing models



Traditionally, there are several ways to introduce style factors into regression models. The use of long-only factors models (a) gives strong explicative regressions, with limited alpha and residual, as the market is embedded within each factor. In this model, the absolute performance of a portfolio in a n-factor framework is described by the arbitrage pricing theory (APT) of Ross (1976) in which the return on asset i is driven by a standard linear factor model:

$$R_i = \alpha_i + \sum_{j=1}^{n_F} \beta_i^j F_j + \varepsilon_i \quad \text{(a)}$$

where α_i is the intercept, β_i^j is the sensitivity of asset i to factor j, F_j is the (random) value of factor j and ε_i is the idiosyncratic risk of asset i. F_j can be one or a combination of long-only factors among size, value, momentum, low volatility, quality and ESG.

It is also commonly accepted to replace exogenous long-only factors with excess performances (b). Let R_M be the performance of the benchmark. In an excess return factor model, the excess performance of one portfolio in a n-factor framework is equal to:

$$(R_i - R_M) = \alpha_i + \sum_{j=1}^{n_F} \beta_i^j \cdot (F_j - R_M) + \varepsilon_i \quad \text{(b)}$$

A third solution consists of considering long/short factors (c), in which the performances of the long-short factors supersede their excess returns:

$$R_i = \alpha_i + \beta_i^M R_M + \beta_i^{SMB} \text{SMB} + \beta_i^{HML} \text{HML} + \beta_i^{WML} \text{WML} + \beta_i^{VOL} \text{VOL} + \beta_i^{QMJ} \text{QMJ} + \varepsilon_i \quad \text{(c)}$$

where SMB (small minus big) is the return on a portfolio of small stocks minus the return on a portfolio of big stocks, HML (high minus low), the return spread between high and low valued stocks, WML (winner minus looser) the return spread between past winners and losers, VOL (volatility) the return spread between high and low volatility stocks, and QMJ (quality minus junk) the return spread between quality and junk stocks.

The most commonly used model in the academic literature is generally based on the long/short equation model (c). In this paper, we chose to use long-only factors (a) as excess returns (b) and long/short portfolios (c) are more sensitive to noises and provide poorer determination coefficients. This also helps study extra-financial best and worst-in-class exposures on long-only style factors separately, to analyze to what extent traditional factors make it possible to differentiate the degree of ESG integration. However, this methodology introduces a systematic positive exposure as the market is, by construction, embedded within every factor, which explains why exposures might seem shifted-up and why there is no need to add the market in the panel of exogenous variables. It would, on the other hand, make sense to

focus on the performance specifically related to ESG, which would be more clearly expressed by excess returns (b) or long/short factors (c). We found, however, no significant differences in terms of trends in relative exposures performing any of the following three equations above. Moreover, we also performed correlation studies and cluster analyses that were based on excess returns (b).

ESG integration in multi-factor frameworks has been performed by many researchers, brokers and providers, but results are, here again, quite erratic over time. Both researchers, like the forerunning Derwall *et al.* (2005)[12] or Corten *et al.* (2005)[13], or banks, brokers and providers that are more contemporary, like J.P. Morgan or the MSCI, have studied the consequences of ESG integration in factor investing strategies. While previous studies usually assimilate ESG as a source of alpha, the more recent ones highlight correlations between ESG and traditional market factors. Breedt *et al.* (2018), showed no evidence that ESG should be considered as a unique equity factor, as excess return implied by ESG integration is already captured by well-known equity factors. Their study also revealed that the excess performance obtained with the governance factor was mainly due to its correlation with the quality factor. On the other hand, some reported that ESG can enhanced quality, dividend yield, price momentum and low volatility strategies.

The change from alpha generation to ESG Beta assessment is due to the fact that the explanatory power of current long-only factor models is now generally too high to be able to deduce a significant ESG-related residual. In other terms, ESG practices measured, and transmitted to pricing models are more likely to affect already known financial ratios, and so be transmitted to already known style factors, than generating an uncorrelated and unknown rewarded signal; a so-called "*new*" *alpha*. In this paper, we study the relevance of ESG factors, comparing them to others long-only factor as stand-alone explicative variable and studying their integration in multi-factor frameworks. In other terms, this part is aimed at assessing if the former ESG alpha may be considered today as a source of beta.

The last part of Giese *et al.* (2018) study found that ESG integration with common factors was to some extent a matter of a trade-off between a targeted ESG score and style factor exposures. Indeed, defining ESG as a linear combination of common quantitative style factors essentially implies that applying an ESG constraint will generate a progressive deviation in terms of targeted active factor exposure. This trade-off was measured introducing

[12] *Based on high-ranked and low-ranked portfolio performances in a CAPM and industry adjusted multi-factor model of US stocks between 1995 and 2003 with Innovest Environmental data.*

[13] *ESG integration in a Fama and French model performed with ESG Vigeo scores between 2000 and 2003 revealed lower risk-adjusted returns from low rated companies but that outperformance of well rated stocks comes with a size bias, overweighting large capitalization.*

a sacrifice ratio defined as the percentage decrease in factor per percentage increase in ESG exposure. More generally, the magnitude of the deviation from a factor investing portfolio exposure to a targeted factor will most reasonably be inversely proportional to the "*degree of similarity*" between the style factor and ESG factor. For instance, if the best ESG quintile of the parent index is strongly and positively correlated to quality and quite neutrally to momentum, applying an ESG constraint on top of a quality strategy should generate a smaller change in quality exposure than it would in a strategy explicitly momentum. This paper also aims at evaluating these similarities than will be defined following different methodologies.

In this study, we chose to construct purely extra-financial time-series using ratings and study both their added value in prediction systems and their overlay with other style factors. ESG integration and correlations might have evolved over the last decades; therefore we decided to track the fluctuations of loading factors of best and worst quintiles in few universes.

4.2.Assessment methodologies of ESG as a new risk factor

The relevance of introducing a new investment factor based on ESG criteria can be assessed using different methodologies. We decided to combine various approaches to confirm our findings. By construction, the time-series studied in this part presents similarities and sometimes embed the same information, therefore the following cross-section and time-series regressions were performed as complementary evaluations of ESG signals added value. We then decided to analyze a selection model to rank ESG factor among all known style factors. The last step was to evaluate the correlations and exposures between extra-financial factors and historically identified style factors.

4.2.1. Exogenous variable analysis

The first systematic step was to introduce ESG-based time-series as exogenous variables and measure the improvement of explicative models. The endogenous variables used to measure ESG and pillar series adding value were the performances of each security using a cross-section approach. In this approach, we broadly analyze the residuals searching for a relationship between each security ESG score and its alpha, which gave no conclusive results. The assessment methodology combines several regression models.

As a starting point, we ran cross-section stand-alone regressions on individual stocks' absolute returns to measure and compare the average R-squared obtained by each single factor. We used the same two periods, 2010-2013 and 2014-2017. The regression model is:

$$R_i = \alpha_i + \beta_i^j F_j + \varepsilon_i \qquad \text{(d)}$$

where F_j is the time-series of each factor weekly returns, including ESG and individual pillars.

Then, we calculated the R-squared, using the market as the only exogenous variable (CAPM model), and we compared it with cross-section multi-factor regressions (a) considering alternatively different sets of explicative variables. In a first set, we considered the five historically identified factors (1). In a second one, we added ESG to obtain a 6-factor model (2). In a third one, we considered an 8-factor model (3) introducing E/S/G pillars individually rather than ESG as a whole, and finally, we evaluated a 3-factor model (4) focusing exclusively on extra financial pillars:

5-factor model (5F): size, value, momentum, low volatility and quality (1)

6-factor model (6F): 5F and ESG (2)

8-factor model (8F): 5F, environment, social and governance (3)

3-factor model (3F): environment, social and governance (4)

4.2.2. Selection model

In a second step, we introduced a lasso regression analysis method (least absolute selection and shrinkage operator) to identify the most pertinent explanatory variables among our n-factor model. The lasso model is a type of linear regression that selected variables using shrinkage methodology. The lasso approach is usually the recommended solution when dealing with a large universe of exogenous variables, but it may also be applied to a more restricted universe with the same efficiency.

The underlying idea of this analysis is to rank factors, including the ESG factor, on their best to worst explanatory power. We can then select factors that better explain performance, and identify factors showing a high level of multicollinearity. The regression lasso is defined by:

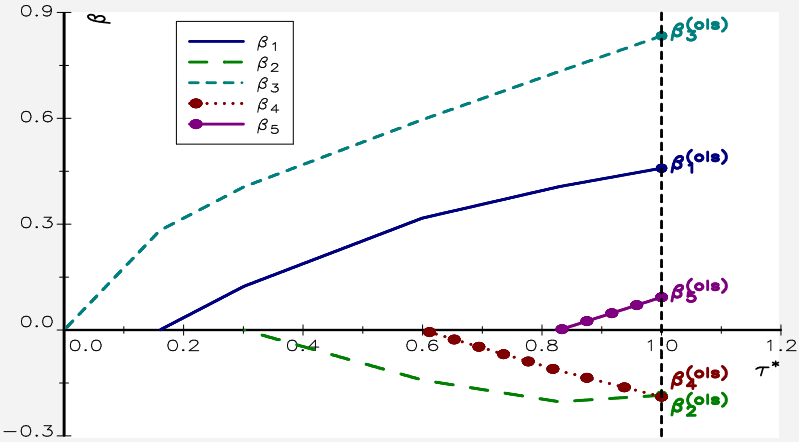
$$R_i = \sum_{j=1}^{\cdot} \beta_i^j F_j + \varepsilon_i$$
$$s.t. \sum_{j=1}^{n_F} |\beta_i^j| \leq \tau$$

where τ is the regulation parameter that controls the strength of the penalty. Figure 45 illustrates the results given by a lasso regression. To make it easier to understand, we introduced τ^* the norm[14] of τ. When $\tau^* = 0$, the penalty is maximum and all β^j coefficients are equal to zero

[14] *Expressed as* $\tau^* = \frac{\tau}{\max(\tau)}$.

and eliminated from the regression model. As the penalty decreases (and τ^* increases), more and more explicative variables are integrated in the model, and when $\tau^* = 1$, no parameters are eliminated, and the final result is equal to the one found with linear regression. In our example, the lasso method selected in priority the F_3 variable to explain the R_i asset performance. Then, it successively added F_1, F_2, F_4 and F_5 factors (Table 6). This means that the most important risk factor for understanding the R_i asset performance was a long exposure to the F_3 factor. The second main risk factor to describe R_i was a long exposure to F_1.

Figure 45: variable selection with the lasso method



Source: Amundi Research

Table 6: Ranking factor

Ranking factor	Factor
1	F_3
2	F_1
3	F_2
4	F_4
5	F_5

4.2.3. Dependency and correlation

In a third step to study extra-financial information, we regressed ESG, E, S and G best and worst-in-class quintile time-series on traditional long-only

style factors. These regressions were performed on a 4-factor framework (5) on rolling periods:

4-factor model (4F): value, momentum, low volatility and quality (5)

In this part, we introduced the size factor differently. We previously confirmed that in each region, size bias comes with ESG investing. Consequently, we made the choice to embed a non-linear size factor within every other style factor. Every factor is slightly tilted on middle capitalizations, including the hypothetical extra-financial ones, balancing the observed bias toward large caps implied by the scores studied in the previous part. The betas are the daily exposures computed over rolling one-year periods.

Finally, we built hierarchical clusters comparing ESG hypothetical factors performances to common style factors using a set of dissimilarities. The algorithm starts by assigning every factor to its own cluster and then iteratively joins the two most similar clusters until there is just one cluster. Distances were computed by the Lance–Williams dissimilarity update formula according to average link method, i.e., minimizing the average value of all pair wise distances. The resulting graphics display the rooted dendrograms over the two focus periods. We use as an input the excess performance times-series of each style factor compared to its local market. This step makes it possible to assess the relative differences between objects that were, by definition, quite similar when we worked with long-only factors. Correlations and causality were also computed on the same excess performance of the long-only factors. No significant and stable causal effects were revealed by Granger causality test between extra-financial and financial factors.

4.3.ESG integration into local frameworks

North America

In the previous part, we showed that North America tracked a changing in trend and that ESG was increasingly rewarded in the recent period. Used as single factors in a cross-section analysis (Table 7), extra-financial factors are the most explanatory[15]. Regarding the cross-section multi-factor regressions (Table 8), the five-factor model (1) obtains better fits than the hypothetic three-factor extra-financial factor (4). The combination of the financial and extra-financial explicative variables (6-factor model (2) and 8-factor model (3)), improved very slightly the average R-squared of the regressions but not significantly. However, given the scales of the variation it is clear that a pricing model based on financial metrics and the breakdown of E, S and G factors improves the fitting.

[15] *Measured by the rankings average R-squared obtained on the cross-section regressions.*

Table 7: Average R-Squared cross section on long-only risk factor									
	Size	Value	Mom.	Vol.	Quality	ESG	E	S	G
2010 - 2013	39.3	38.9	39.6	35.8	39.1	40.1	40.0	40.0	40.4
2014 - 2017	23.6	24.4	23.6	22.2	24.1	25.1	25.5	24.9	25.2

Table 8: Average R-Squared MSCI cross sectional multifactor models [North America]		
	2010 – 2013	2014 - 2017
CAPM	40.4	25.5
5F	46.1	35.4
3F	42.0	30.2
6F	46.7	36.8
8F	47.7	39.0

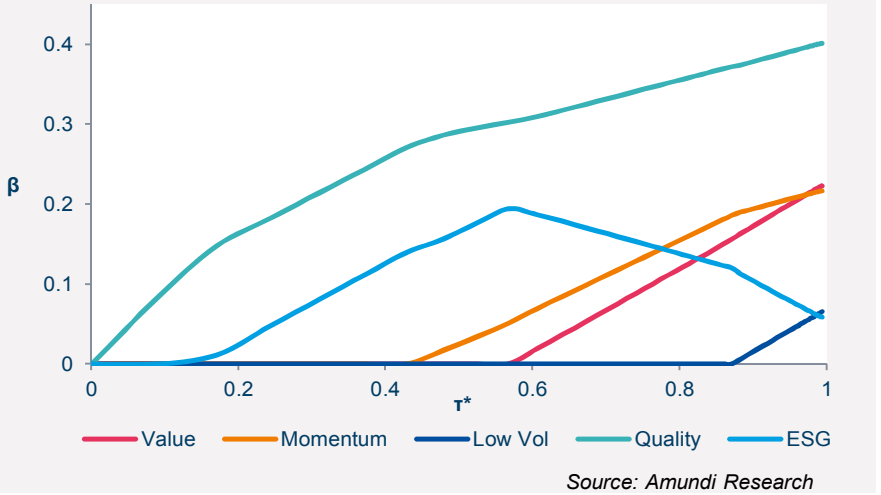
To determine how information is shared between ESG and common factors, we studied the exposures of the MSCI North America index's performance to each style factors between 2013 and 2017 (Table 9). In a traditional framework, we expect such time-series to be neutrally[16] or negatively exposed to size, by construction of market cap weighted indexes, and to have exposures on other style factors that depend mostly on the market cycle (1). ESG factor inclusion reduces other factor loading without significantly increase the explanatory power of the regression (already high as we are working on a diversified index). The regression (3) shows that the environmental best-in-class time-series contains most of the information which is in line with our previous results. However, ESG time-series is less significant than E (3) that presents both higher exposure and p-value.

[16] *The neutrality of size also comes from the emphasis of mid applied to style factors to neutralize ESG series biases, but it is mostly caused by the fact that indexes are driven by large caps, representing on average roughly 60% of their allocations.*

Table 9: MSCI Regression in multifactor framework, [North America: 2013-2017]			
	Dependent variable:		
	MSCI North America		
	(1)	(2)	(3)
Size	0.011	-0.001	-0.008
	(0.019)	(0.021)	(0.021)
Value	0.237***	0.230***	0.171***
	(0.024)	(0.024)	(0.025)
Momentum	0.220***	0.219***	0.191***
	(0.026)	(0.025)	(0.024)
Low Volatility	0.081***	0.070**	0.039*
	(0.021)	(0.023)	(0.021)
Quality	0.422***	0.403***	0.255***
	(0.026)	(0.029)	(0.035)
ESG		0.051	
		(0.040)	
E			0.291**
			(0.043)
S			0.042
			(0.040)
G			-0.008
			(0.039)
Constant	-0.002	-0.002	-0.006
	(0.012)	(0.012)	(0.011)
R^2	0.989	0.989	0.991
Adjusted R^2	0.988	0.989	0.991
Residual Std. Error	0.166 (df=198)	0.165 (df=197)	0.150 (df=195)
F Statistic	3,488*** (df=5; 198)	2,916*** (df=6; 197)	2,672*** (df=8; 195)
			Note: *p<0.1; **p<0.05; ****p<0.01

This static regression shows that the extra-financial information is embedded in style factors; i.e., there is redundancy in the information carried by each time-series. We performed a lasso analysis to rank factor's influence on the MSCI North America Index's performance (Figure 46).

Figure 46: Variable selection with lasso model [North America]



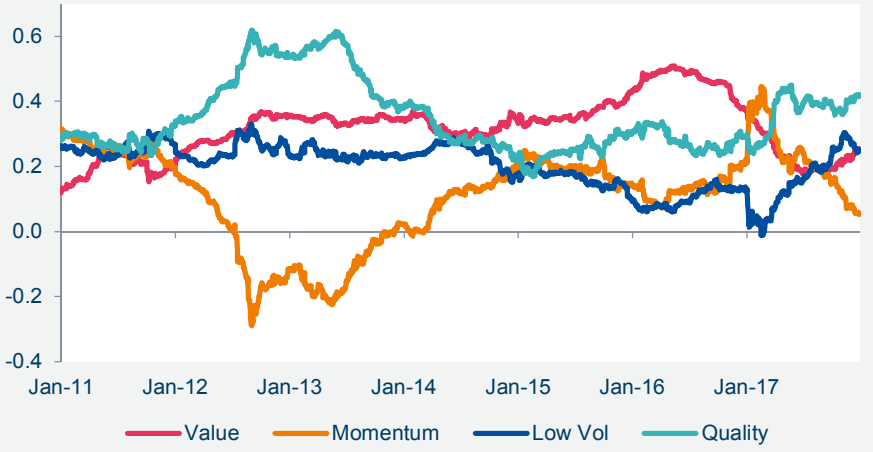
Source: Amundi Research

This analysis points out the factors that should be excluded from the model when increasing the penalty parameter. As explained in the assessment methodology section, the penalty is maximum when τ^* is equal to 0, whereas all risk factors are selected when τ^* is equal to 1. The lasso regression successively excludes low volatility, value and momentum. Ultimately, quality is the most relevant factor to describe the performance of the North America index, followed by the ESG factor. Interestingly, the introduction of the value risk factor in the regression model corresponds to a turning point on the ESG curve. From that point forward, the ESG coefficient starts to decrease, pointing to the overlap between ESG and both value and low volatility factors.

We applied the same methodology to rolling periods, looking for trends over time. If factor exposures of both best and worst quintiles in this market have been time variant, we can observe major contribution from some of the existing style factors. There would be no need for an ESG-specific factor if responsible investing can be expressed as a linear combination of existing factors. Figures 47 and 48 show that investing in worst-in-class is defined as a combination of momentum and value, i.e. the last quintile exposures. On the other hand, results are much more erratic when it comes to invest on well

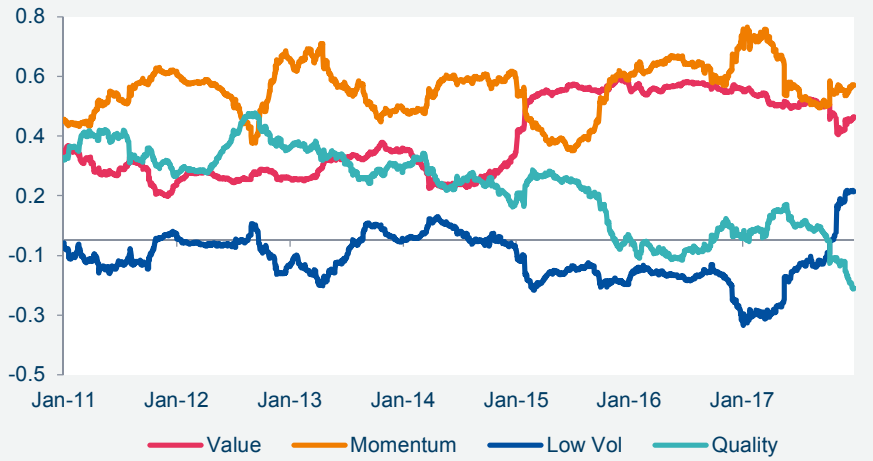
rated securities in the recent period. ESG and S (Figures 51 and 52) have very similar profiles on this universe, which is in line with previous results. ESG exposures seem, however, to present quite cyclic exposure in the two periods with a slight hint of a return to the previous exposures late in the second period.

Figure 47: Time variant exposures – ESG Q1 [North America]



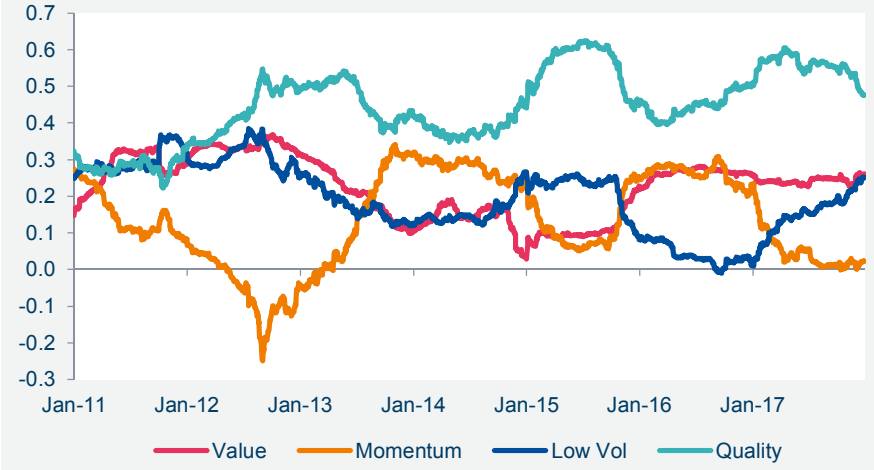
Source: Amundi Research

Figure 48: Time variant exposures - ESG Q5 [North America]



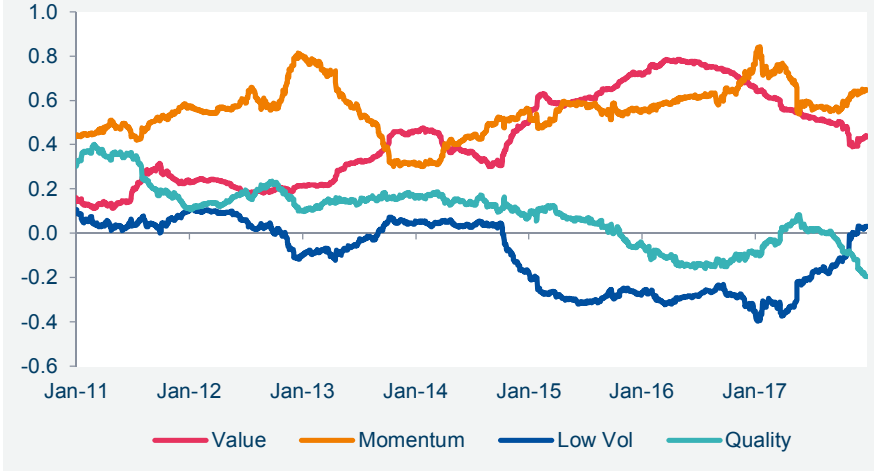
Source: Amundi Research

Figure 49: Time variant exposures - E Q1 [North America]



Source: Amundi Research

Figure 50: Time variant exposures - E Q5 [North America]

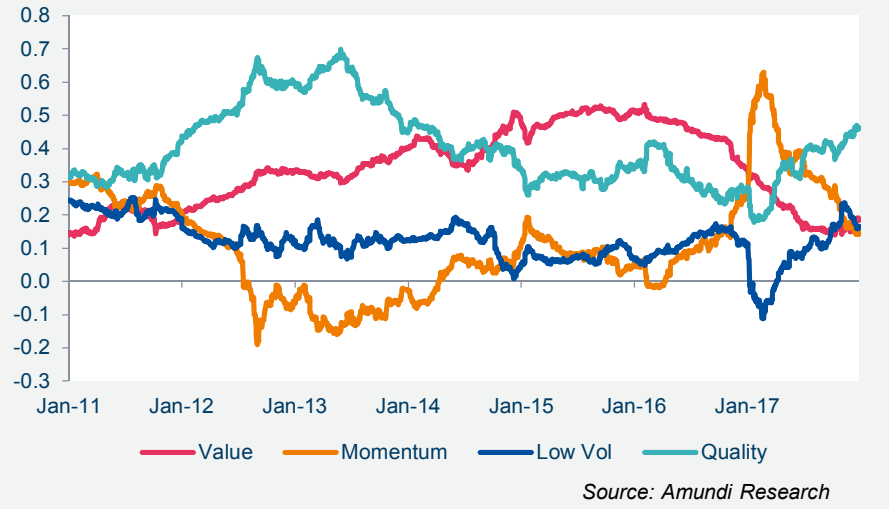


Source: Amundi Research

ESG, E, and S present a clear contrast between best and worst in terms of quality loading in the second period, with a strong dominance of this factor exposure for best-in-class over the whole period (Figures 47 to 52). Value loading is quite strong for both best and worst, in both periods, and is the most constant exposure. It is therefore, not a differentiation factor in term of responsible investing. The last

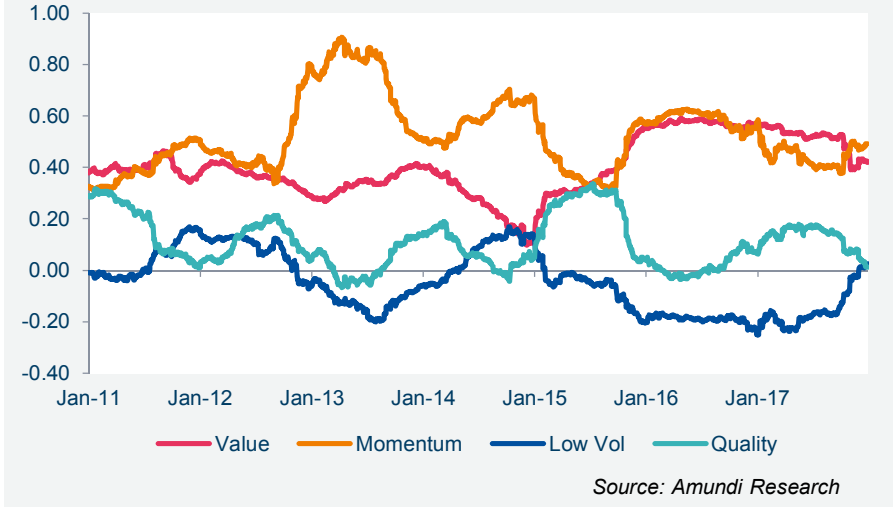
quintiles are usually highly momentum in the first period, while the best ones have lower and sometimes negative momentum contributions. We note that the G pillar is not in line with others pillars in terms of factor exposures. Indeed, the first and worst governance quintile exposures are closer (Figure 53 and 54). The governance best quintile shows a very strong contribution of value style factor, but this influence was effective over hardly one year.

Figure 51: Time variant exposures - S Q1 [North America]



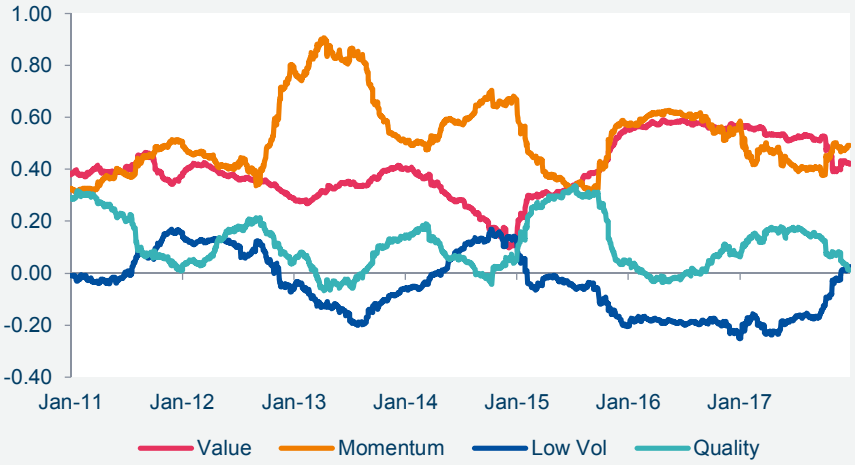
Source: Amundi Research

Figure 52: Time variant exposures - S Q5 [North America]



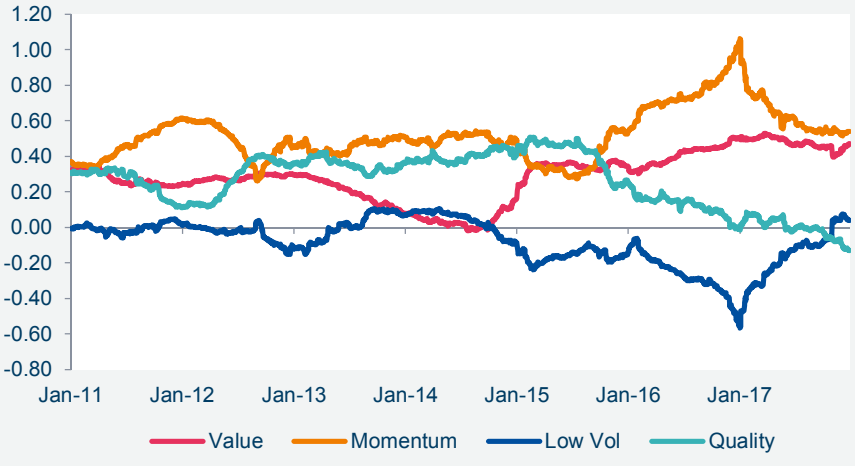
Source: Amundi Research

Figure 53: Time variant exposures - G Q1 [North America]



Source: Amundi Research

Figure 54: Time variant exposures - G Q5 [North America]

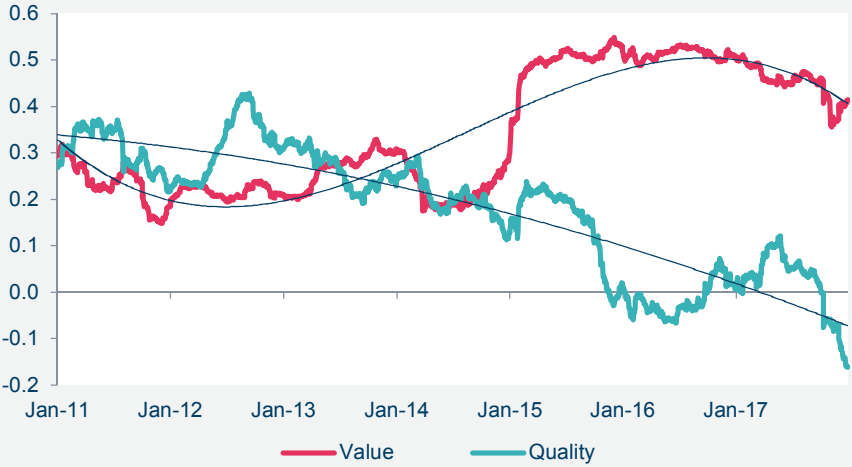


Source: Amundi Research

The contrast between best and worst-in-class exposures is widening in North America, mainly because of worst-in-class explicit exposures shifting. The first quintiles are more exposed to quality, value and, to

some extent, low volatility, while the worst are mostly momentum, anti-low volatility and, increasingly, value. It would be presumptuous to affirm that such trends will last from these varying profiles. The focus (Figure 55) shows indeed a strong shifting in 2015 ex-post exposures, computed with 2014 returns. However, there is a slight decrease late in the period, which raises the matter of the consistency of associating "anti-ESG" with value. This variation is likely to come from changes in terms of investors' demand progressively affecting asset valuation. We also point out that both best and worst are generally highly exposed to this factor.

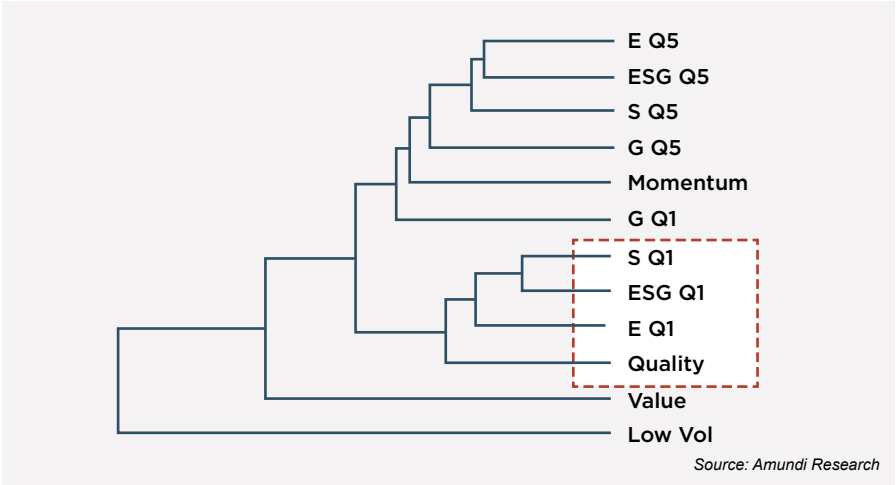
Figure 55: Exemple of trend : ESG Worst-in-class [North America]



Source: Amundi Research

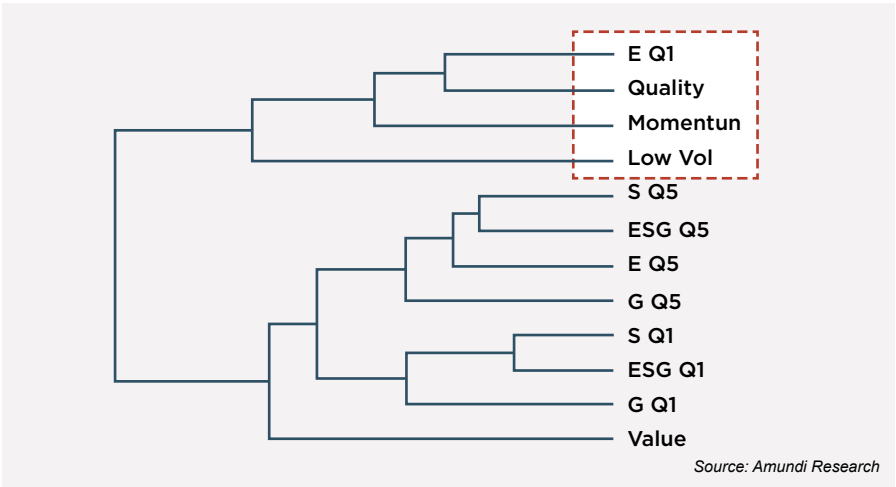
The hierarchical clustering (Figure 56) shows that in the 2010-2013 period, the best ESG, E and S quintiles have a similar behavior and are mostly exposed to quality. The most influential style factor for ESG worst quintiles was momentum between 2010 and 2013. We can also note that the best quintile in terms of governance is not in the same cluster than the rest of the best-in-class, which reveals in North America, governance criteria were less considered in pricing, perhaps because of the maturity of governance concerns in this zone makes ranking according to these criteria less meaningful.

Figure 56: North America cluster dendrogram 2010-2013



Source: Amundi Research

Figure 57: North America cluster dendrogram 2014-2017



Source: Amundi Research

Best and worst social and ESG quintiles are highly similar, confirming the observation made on the rolling loading analysis. The first environmental quintile presents in the recent period (Figure 57) more similarity with quality factor than with any other ESG quintile. It also forms a level 2 cluster with momentum and level 3 with low volatility, which indicates that securities considered as environmentally responsible in North America have performed well recently

with quite low volatility. We see that the G first quintile is not excluded anymore with worst-in-class and has now more similarities to the other first quintiles.

These results are in line with the previous ones and complementary studies (Figure1 and Table 1 in Appendix B). In terms of factorial integration, however, it shows no significant exposure for best-in-class. Worst-in-class, on the other hand, have major explanatory loadings style factors. These major exposures do not always make it possible to discriminate between best and worst quintiles. In the second period, for example, hierarchical clustering shows that the cluster formed by the last quintiles presents more similarities with the one formed with the best than with value, which is its major explanatory factor. Even if they don't directly improve predictive models, the construction of extra-financial factors remains a consistent option to shift financial performance modeling processes toward more sustainability. However, the only priced pillar presents increasing similarities with quality.

EMU

Cross-section analyses provide evidence that models integrating extra-financial information improve, at least slightly, the explanatory power of the regressions, and that they have, as a single factor, some informational value that leads to higher R-squared than any other factor. Table 10 below displays the R-Squared obtained by regressing the performance of each security within the EMU on each factor. ESG seems to come first. However, it has been shown that ESG does embed common style factors, which could explain this slight increase of explanatory power.

Table 10: Average R-squared cross-section on long-only risk factor [EMU]

	Size	Value	Mom.	Vol.	Quality	ESG	E	S	G
2010 - 2013	37.1	41.6	40.8	38.7	42.4	42.6	12.3	41.9	42.3
2014 - 2017	20.9	35.2	35.8	36.5	36.5	37.3	12.2	36.4	37.0

Table 11: Average R-squared cross-sectional multifactor models [EMU]

	2010 – 2013	2014 - 2017
CAPM	42.8	37.7
5F	49.5	45.3
3F	43.9	39.5
6F	50.1	46.0
8F	50.9	47.2

The explanatory power of the 5-factor framework regression of returns is very slightly, or not improved by the insertion of ESG factors; i.e., we observe very little or no improvement of regression adjusted R-squared (Table 11). Moreover, the residuals of the ESG quintiles are often not statistically different from a white noise. The detail of the regressions of the global MSCI EMU in the second period

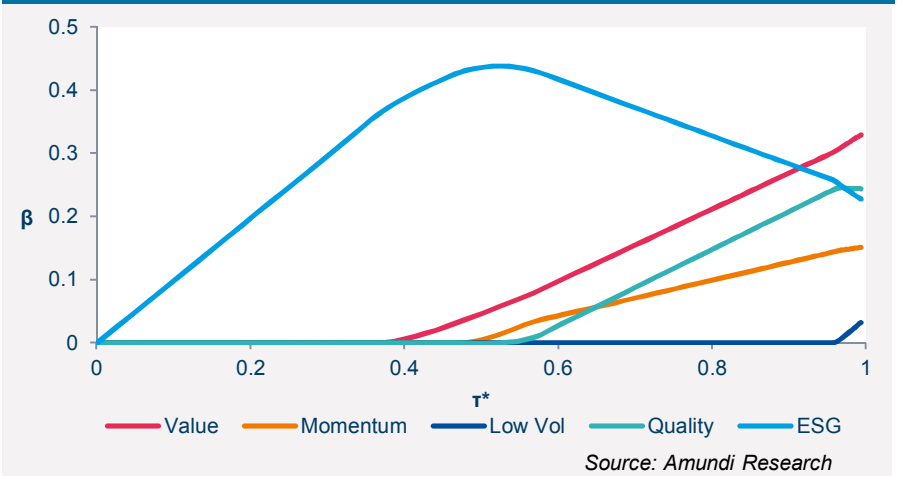
on the long-only model (1), the 6 and 8-factor ones (2) (3) are given in Table 12. ESG time-series has a robust beta that is mostly due to its G component.

Table 12: Regression in multifactor framework [EMU: 2013-2017]

	Dependent variable:		
	MSCI EMU		
	(1)	(2)	(3)
Size	0.006	0.008	0.004
	(0.009)	(0.009)	(0.009)
Value	0.419***	0.307***	0.387***
	(0.017)	(0.025)	(0.022)
Momentum	0.146***	0.143***	0.096***
	(0.031)	(0.029)	(0.032)
Low Volatility	0.144***	0.054	0.138***
	(0.041)	(0.041)	(0.040)
Quality	0.314***	0.245***	0.271***
	(0.049)	(0.047)	(0.047)
ESG		0.267***	
		(0.046)	
E			-0.022***
			(0.007)
S			-0.031
			(0.036)
G			0.186***
			(0.039)
Constant	-0.053***	-0.058***	-0.050***
	(0.019)	(0.018)	(0.018)
R^2	0.986	0.988	0.988
Adjusted R^2	0.986	0.988	0.988
Residual Std. Error	0.268 (df=198)	0.249 (df=197)	0.250 (df=195)
F Statistic	2,785*** (df=5; 198)	2,702*** (df=6; 197)	2,007*** (df=8; 195)
			Note: *p<0.1; **p<0.05; ****p<0.01

We also performed a lasso[17] algorithm to determine which variable would be selected to reduce financial pricing models' complexity. It helps to understand how to deal with redundancies in the computation of the betas as a function of the lambda penalization parameter. Figure 58 presents the lasso regression of the MSCI EMU Index on style factors.

Figure 58: Variable selection with the lasso method [EMU]



Source: Amundi Research

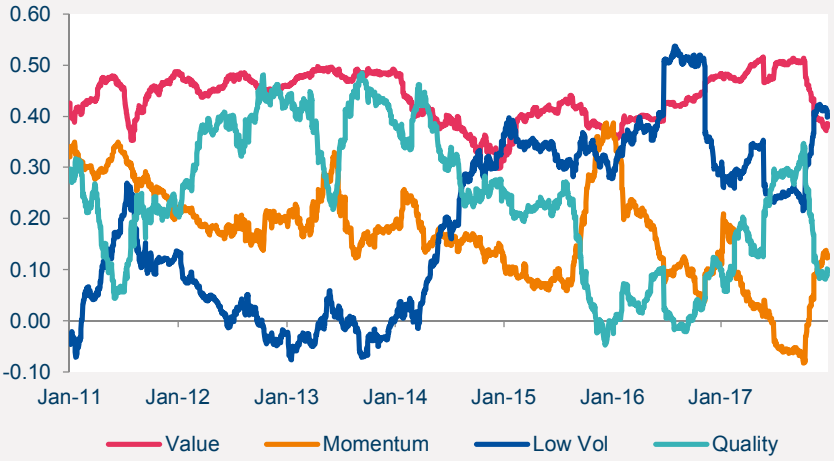
Figure 58 shows that ESG is the factor that best describes the total performance of the MSCI EMU if we have to choose only one factor. This is in line with the R-squared obtained on the cross-section analysis (Table 10). Since there are obvious redundancies, the beta attributed by the model to the ESG factor decreases when we introduce more factors into the model. Adding value factor reduces the slope of the ESG beta, as does momentum and, finally, the introduction of quality takes over the ESG loading. The final betas are defined by the final exposures reached. This experiment also confirms that ESG can be partially explained by common factors, but still have an important loading (third most explicative variable after value).

The previous part showed that the Eurozone rewards ESG criteria. In terms of factors exposure, however, the results are far more erratic. One can say that first quintiles are generally highly exposed to value, while the last are mostly momentum. It appears clearly impossible to track ESG investment strategies as a constant combination of style factor, as demonstrated by the curves below (Figures 59 and 60). Moreover, the increase of exclusion

[17] *Least Absolute Selection and Shrinkage Operator*

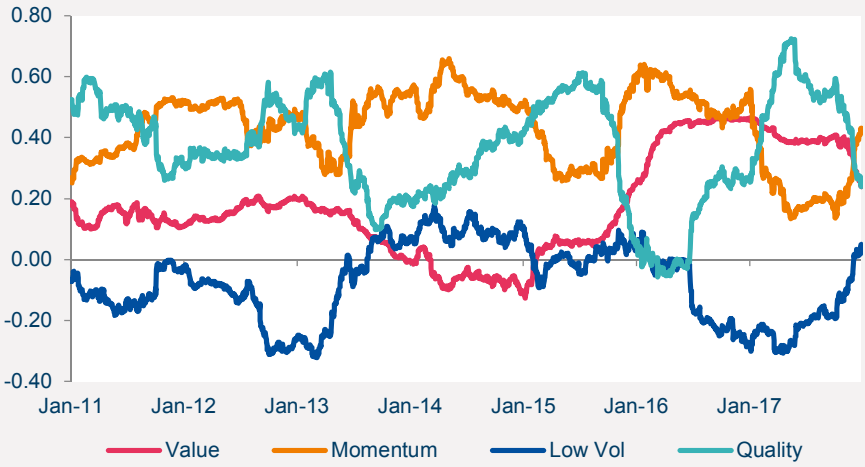
strategies applied by investors negatively impacted the valuation of the securities of the last ESG quintile, which increased worst-in-class value exposure in the second period.

Figure 59: Time variant factor exposures - ESG Q1 [EMU]



Source: Amundi Research

Figure 60: Time variant factor exposures - ESG Q5 [EMU]



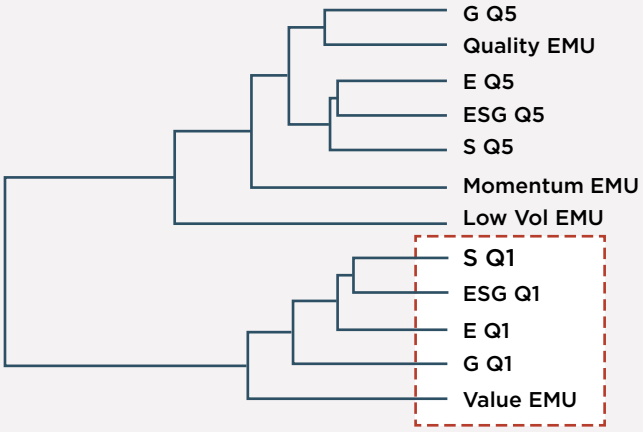
Source: Amundi Research

In terms of relative exposures, there is no obvious way to distinguish best from worst, except by their average, but inconsistent over time, differences in terms of low volatility loadings (on average +0.2 between best and worst). There is, however, a significant change in trend in terms of low volatility for the best quintile, that shifted from negative to positive gaining on average +0.40 between the first and second periods. Results are similar with the E, S and G pillars (Figures 3 to 8 in Appendix B). We can hardly track an ESG strategy combining existing factors. The long/short factor loadings following the model (c) previously introduced present the same trends but centered and with lower magnitudes.

The cluster analysis in Figures 61 and 62 demonstrates that the governance worst quintile is close to quality in the first period. The first quintiles are mostly exposed to value. Low volatility factor is presented as closer, in terms of excess returns, to the last quintile in this period. However, the exposure above clearly shows that extra financial best quintiles were not, or slightly negatively, exposed to this factor between 2010 and 2013.

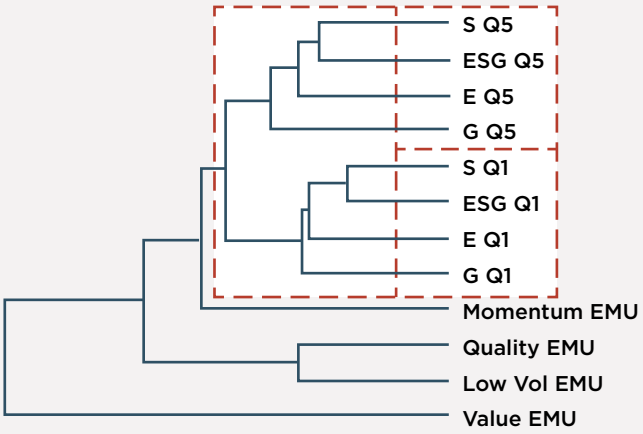
In the second period, the hierarchical clustering clearly demonstrates that both best and worst ESG quintiles form their own cluster away from EMU style factors. More importantly, the graph below reveals that, in the second period, we find more similarities between first and last quintiles than with any other style factor. If it is certain that we can build an ESG strategy whose performance will be captured by time varying loadings on style factors, building an ESG strategy from these factors is not so straightforward.

Figure 61: EMU cluster dendrogram 2010-2013



Source: Amundi Research

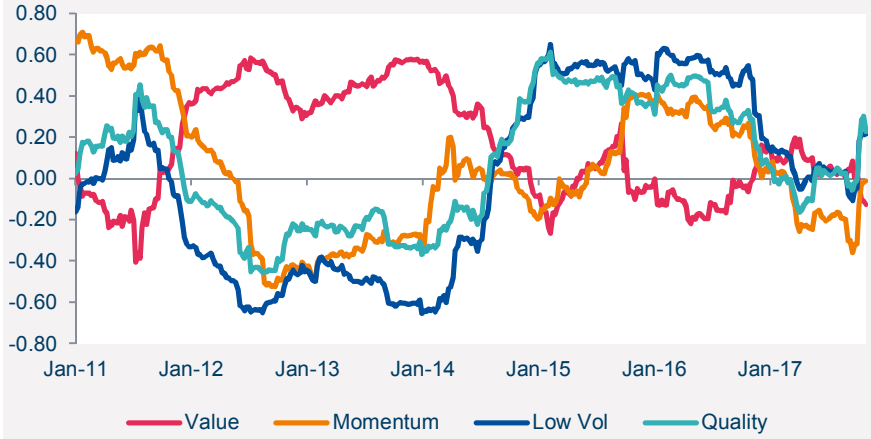
Figure 62: EMU cluster dendrogram 2014-2017



Source: Amundi Research

In addition, focusing on correlations during the same period between existing factors and the ESG first quintile, Figure 63 and Table 13 confirm the previous observations. The existing factors present higher correlation with each other than they do with ESG ones. This also confirms that the ESG first quintile presents in the second period a change in trend and shifted from negative to positive correlation with both low volatility and quality.

Figure 63: ESG Q1
Moving 1Y correlation of excess returns vs MSCI EMU



Source: Amundi Research

Table 13: Average 4-year correlations of excess returns [EMU]					
2010 2013	*Value*	*Momentum*	*Low Volatility*	*Quality*	*ESG*
Value	100%				
Momentum	-42%	100%			
Low Volatility	-80%	37%	100%		
Quality	-66%	49%	82%	100%	
ESG	35%	15%	-35%	-12%	100%

2014 2017	*Value*	*Momentum*	*Low Volatility*	*Quality*	*ESG*
Value	100%				
Momentum	-45%	100%			
Low Volatility	-66%	47%	100%		
Quality	82%	52%	82%	100%	
ESG	-3%	7%	38%	30%	100%

There is no visibility in term of factor loading and long-term correlations. At the end of the period ESG quintiles are not correlated to any factors. There is evidence of a turning point around 2014, which is in line with the results observed on equally weighted portfolios performances analysis (part III). The issue remains of causality, i.e., rather or not changes in ESG times series implies changes in style factors. No conclusion can be drawn from the Granger causality test performed on each time-series.

Given the coefficient of determination obtained with extra-financial enhanced models, the lasso regression results and the distances and correlation between ESG and common style factors, we can seriously consider the creation of an ESG style factor in this specific zone.

Europe ex-EMU

Even the alpha generation was not proved in the section three for passive and active management, we decided to study the pertinence of an hypothetical ESG factor in Europe ex-EMU. This region is subject to currency and country bias. In terms of factor investing, we could expect loading factors to be influenced by macro-economic events, affecting performance on this quite diverse universe. Moreover, we demonstrated in the previous part that extra-financial time-series emphasize different geographical areas; i.e., governance overweights U.K., and the others focus on Norway and Sweden. However, extra-financial single factors obtain similar R-squared than other style factors on average. The metrics on Table 15 also demonstrate that building a model only on extra financial metrics (3-factor model) can beat the CAPM, and that integrating E, S and G pillars as shown in figure 24 slightly improves R-squared.

Table 14: Average R-squared cross-section on long-only risk factor [Europe ex-EMU]									
	Size	Value	Mom.	Vol.	Quality	ESG	E	S	G
2010 - 2013	38.9	38.7	39.4	34.2	39.0	38.9	38.7	39.2	38.5
2014 - 2017	33.3	31.2	33.0	32.5	33.3	34.1	33.6	33.8	33.0

Table 15: Average R-squared cross-sectional multifactor models [Europe ex-EMU]		
	2010 – 2013	2014 - 2017
CAPM	40.3	34.4
5F	47.9	42.7
3F	41.6	38.0
6F	48.8	43.5
8F	50.1	46.0

The regression of this index total performance on a multi-factor panel displays (Table 16), as in the other regions, varying metrics and reveals overlays. ESG factor introduction as an exogenous variable reduces common style factors exposures slightly, but the model based on style factors and ESG pillars (3) provides the most explicative regression with, in this case, a significant[18] contribution of every extra-financial factor[19]. On the other hand, governance seems to have a minor and slightly negative influence on this period.

Table 16: Regression in multifactor framework, 2013-2017 [Europe ex-EMU]			
	Dependent variable:		
	MSCI Europe Ex-EMU		
	(1)	(2)	(3)
Size	-0.130***	-0.121***	-0.117***
	(0.029)	(0.029)	(0.028)
Value	0.393***	0.353***	0.349***
	(0.024)	(0.029)	(0.030)
Momentum	-0.021	-0.032	-0.056
	(0.042)	(0.042)	(0.040)

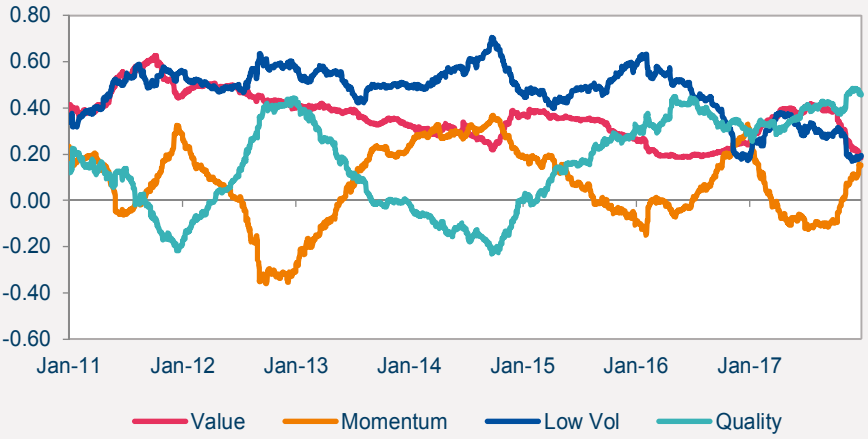
[18] *As demonstrated by their p-values Table 16.*

[19] *The country-specific characteristic of E, S and G factors in this aggregated universe might explain the equal-robustness of each extra-financial factor, channeling the contribution of each country to the overall performance.*

Low Volatility	0.488***	0.444***	0.409***
	(0.040)	(0.044)	(0.041)
Quality	0.256***	0.226***	0.214***
	(0.052)	(0.053)	(0.050)
ESG		0.110**	
		(0.048)	
E			0.125***
			(0.038)
S			0.163***
			(0.040)
G			−0.098**
			(0.040)
Constant	-0.013	-0.012	-0.004
	(0.023)	(0.022)	(0.021)
R^2	0.975	0.975	0.979
Adjusted R^2	0.974	0.975	0.978
Residual Std. Error	0.322 (df = 198)	0.319 (df = 197)	0.298 (df = 195)
F Statistic	1,532*** (df = 5; 198)	1,305*** (df = 6; 197)	1,123*** (df = 8; 195)
			Note: *p<0.1; **p<0.05; ****p<0.01

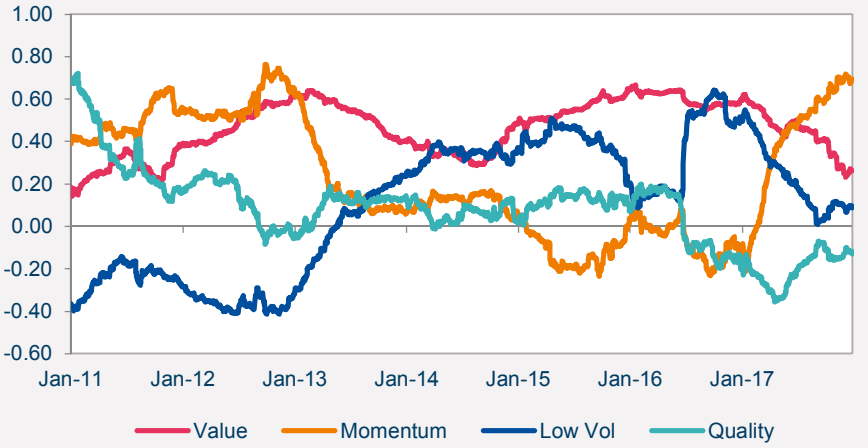
In the previous part, we showed that the ESG equally weighted best-in-class quintile in Europe Ex-EMU presents more stable outperformance. Results were not conclusive, however. The static regression in Table 16 implicitly shows that ESG factor carries some slight negative influence from size, and positive influence from value, quality and low volatility. As in North America, the high loadings in value are common to best and worst (Figures 64 and 65). Again, strong value exposure does not define an ESG strategy. Indeed, to build a coherent model from ESG ratings, there must be a consistency between the three equations previously presented. In the extension of the long/short model (c), the risk premia that would be associated with ESG, i.e., by buying the best and selling the worst, would not be captured by the value (HML) factor.

Figure 64: Time variant factor exposures – ESG Q1 [Europe ex-EMU]



Source: Amundi Research

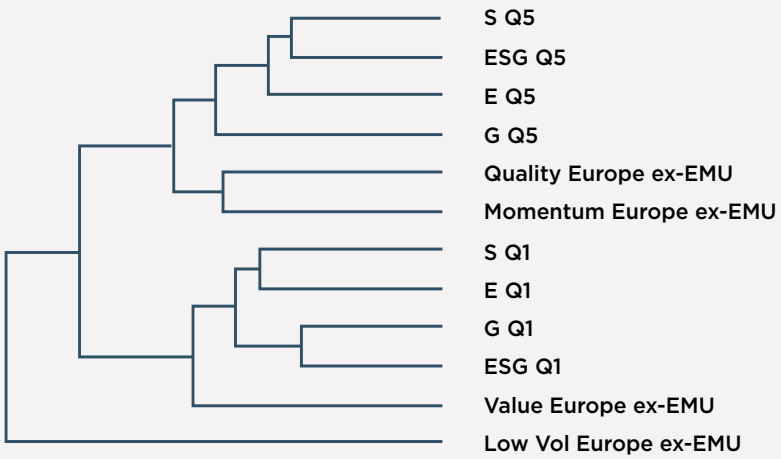
Figure 65: Time variant factor exposures - ESG Q5 [Europe ex-EMU]



Source: Amundi Research

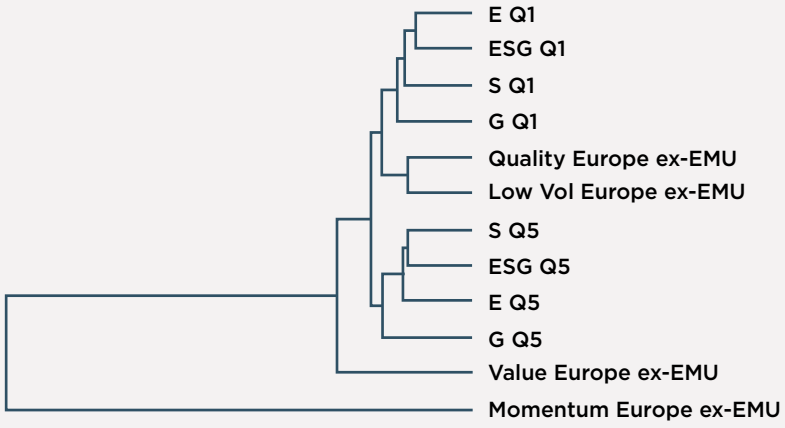
In contrast to the performance profiles (part III), which were quite erratic, E, S and G pillars in Europe ex-EMU present rolling exposures that are very similar to ESG global scores (Figures 8 to 13 in Appendix B) . ESG investing seems to get close of forming a cluster with both quality and low volatility in the second period (Figures 66 and 67).

Figure 66: Europe Ex-EMU cluster dendrogram 2010-2013



Source: Amundi Research

Figure 67: Europe Ex-EMU cluster dendrogram 2014-2017



Source: Amundi Research

The correlations between the factor formed by the ESG first quintile are stable for value, but clearly increasing (+0.3) for low volatility, momentum and quality. There have been highly inconsistent correlations over the period (Figures 14 and Table 2 in Appendix B).

Japan

MSCI Japan presented a stronger ESG integration between 2013 and 2014 (Figures 24 and 26). The performance analyses results are, however, erratic while changing the weighting methodology, and pillars valuation does not present conclusive results. From a quantitative perspective, single factor regression models show that any ESG factor explains, on average, 40% of Japanese assets' performance in the second period (Table 17). The result of the CAPM can be reproduced on a purely extra-financial base (3-factor model in Table 18) but not improved, and the eight-factor model compiling financial and extra-financial information raises by 10% the explanatory power of the CAPM on cross-asset regressions.

Table 17: Average R-squared cross-section on long-only risk factor [Japan]

	Size	Value	Mom.	Vol.	Quality	ESG	E	S	G
2010 - 2013	35.3	35.1	35.2	28.8	35.6	35.7	35.2	36.1	35.6
2014 - 2017	40.7	39.5	39.4	39.8	40.7	41.2	41.0	41.3	41.3

Table 18: Average R-squared cross-sectional multifactor models [Japan]

	2010 – 2013	2014 - 2017
CAPM	37.4	42.7
5F	46.0	50.5
3F	37.8	42.7
6F	46.8	51.2
8F	47.7	52.1

The introduction of an ESG factor into pricing models is presented in Table 19. Indeed, ESG seems to mostly reduce the value exposure with lower participation of other style factors. The breakdowns between pillars show that the information affecting the index is carried by environmental and social time-series that have more significant loadings.

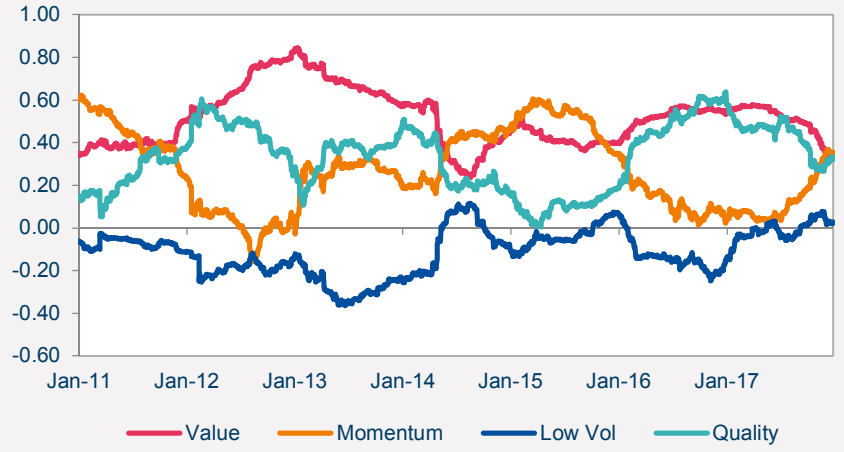
Table 19: Regression in multifactor framework, 2013-2017 [Japan]

	Dependent variable:		
	MSCI Japan		
	(1)	(2)	(3)
Size	0.042	0.020	0.014
	(0.026)	(0.023)	(0.022)

Value	0.408***	0.292***	0.289***
	(0.020)	(0.023)	(0.023)
Momentum	0.202***	0.171***	0.149***
	(0.026)	(0.023)	(0.023)
Low Volatility	0.054**	0.085***	0.068***
	(0.025)	(0.022)	(0.021)
Quality	0.294***	0.202***	0.225***
	(0.033)	(0.031)	(0.030)
ESG Q1		0.228***	
		(0.029)	
E Q1			0.143***
			(0.035)
S Q1			0.114***
			(0.039)
G Q1			-0.007
			(0.037)
Constant	-0.022	-0.019	-0.023*
	(0.016)	(0.014)	(0.013)
R^2	0.994	0.995	0.996
Adjusted R^2	0.993	0.995	0.995
Residual Std. Error	0.220 (df = 198)	0.192 (df = 197)	0.184 (df = 195)
F Statistic	6,116*** (df = 5; 198)	6,659*** (df = 6; 197)	5,447*** (df = 8; 195)
			Note: *p<0.1; **p<0.05; ****p<0.01

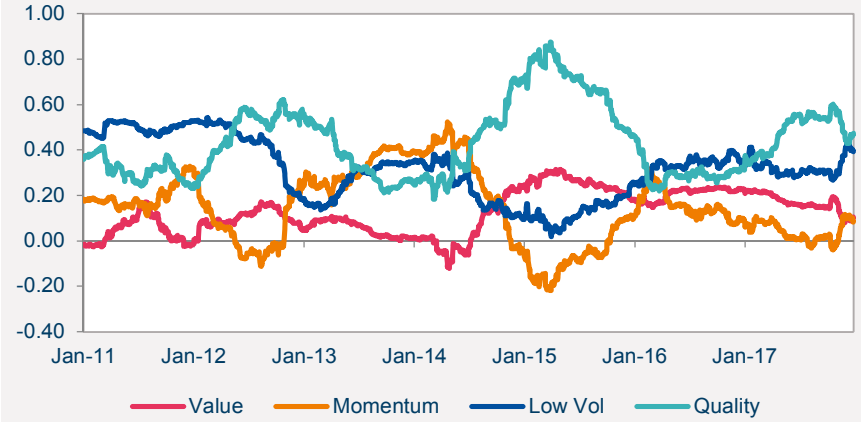
Japanese ESG best-in-class assets are strongly exposed to value and quality and slight negatively low volatility (Figure 68), which could be unexpected, based on other region exposures. Moreover, we note higher exposures on quality and low volatility (Figure 69) for the last quintile. The latter quintile quality exposure is clearly periodical and opposed to momentum loadings.

Figure 68: Time variant factor exposures - ESG Q1 [Japan]



Source: Amundi Research

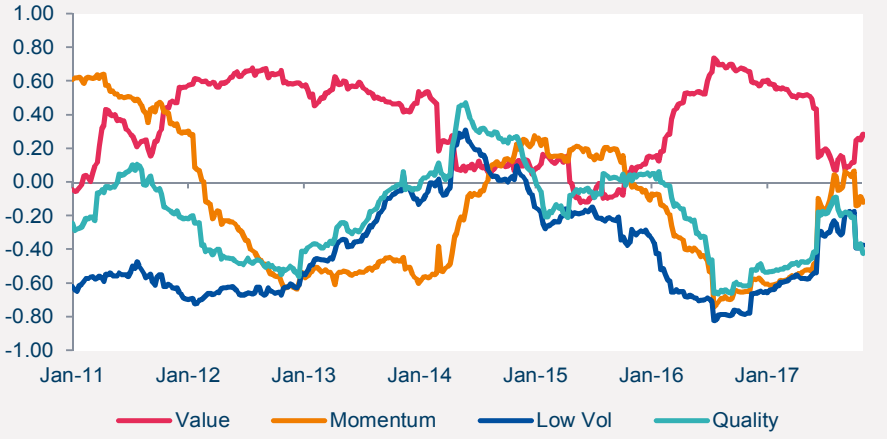
Figure 69: Time variant factor exposures - ESG Q5 [Japan]



Source: Amundi Research

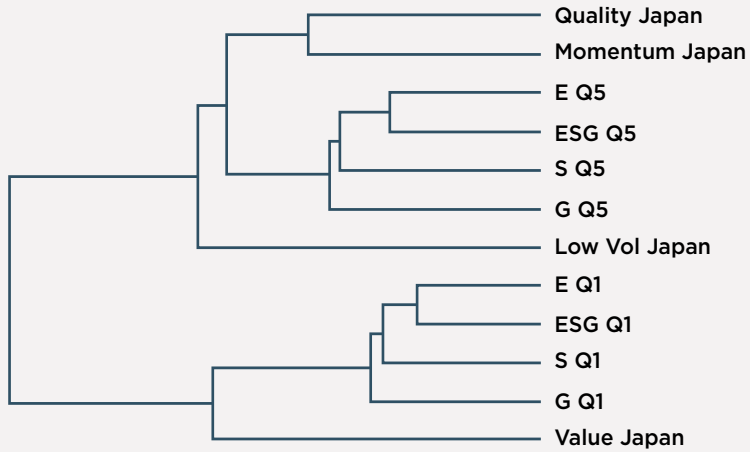
Japan has demonstrated time-varying and quite periodical correlations between ESG first quintile and other style factors (Figure 70 and Table 3 in Appendix B), but it clearly appears from both rolling one-year correlations and clustering analysis that ESG investing is close to value and negatively correlated with other style factors, on average, in the second period.

Figure 70: ESG Q1
Moving 1Y correlation of excess returns vs MSCI Japan



Source: Amundi Research

Figure 71: Japan cluster dendrogram 2014-2017



Source: Amundi Research

From these varying exposures and correlations, one can explain a portfolio's ex-post performance with a regression but not to apply an ESG-driven process based on ex-ante factor exposures in Japan. However, value investment seems to be "*the closest*" to ESG investing in this region.

4.4.World Aggregated ESG Factor

We have demonstrated that each area had its specificities in terms of ESG exposures and that the loadings were highly instable over time. One can also note that correlations between financial and extra-financial time-series even tended to decrease in late 2017, but this slight inflexion is not significant. Factor investing in a global universe uses the aggregation of local style factors following the pro-rata of regions' weightings in the MSCI World Index. We revealed that it would be highly controversial to conclude that ESG investing in individual regions is a constant mix of negative size, positive value, low volatility and quality. Moreover, in an investment framework that is likely to become more and more regulatory, it would qualitatively make sense to insert some extra-financial signals into factorial processes. Figures 72 to 74 present two static views of the cumulative performance of the aggregated global equity common style factor metrics and the cumulative performance of the hypothetical ESG factor built, based on the same methodology.

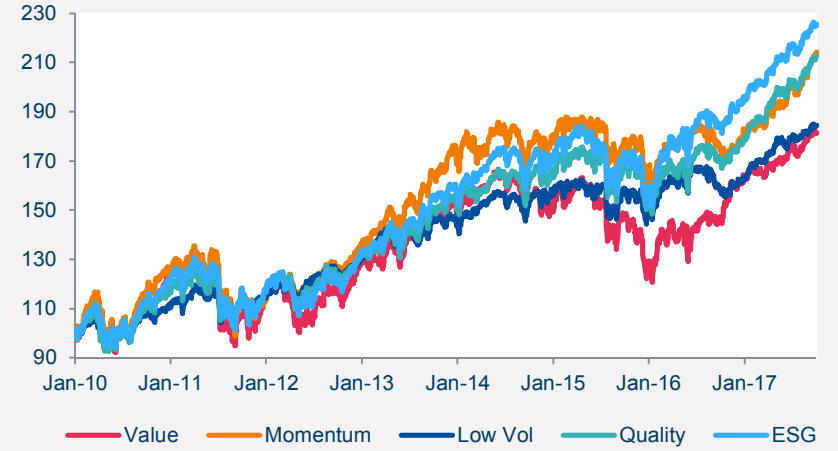
Figure 72: Factor Efficient Frontier [MSCI World Index : 2010 - 2013]

Source: Amundi Research

Figure 73: Factor Efficient Frontier [MSCI World Index : 2014 -2017]

Source: Amundi Research

Figure 74: World factors performance profile



Source: Amundi Research

The ex-post mapping of risk-adjusted performances is indicative of the final similarities between ESG and quality in terms of financial expectation and presents this new factor as riskier and more rewarded (Figures 72 and 73),

shifting of the quality driven investment profile on the efficient frontier. In terms of metrics, low volatility, quality and ESG present the same Sharpe ratios computed with the performance between 2010 and 2017.

The performance of a portfolio i can be expressed in a long-only multi-factor framework enhanced by extra-financial information as followed:

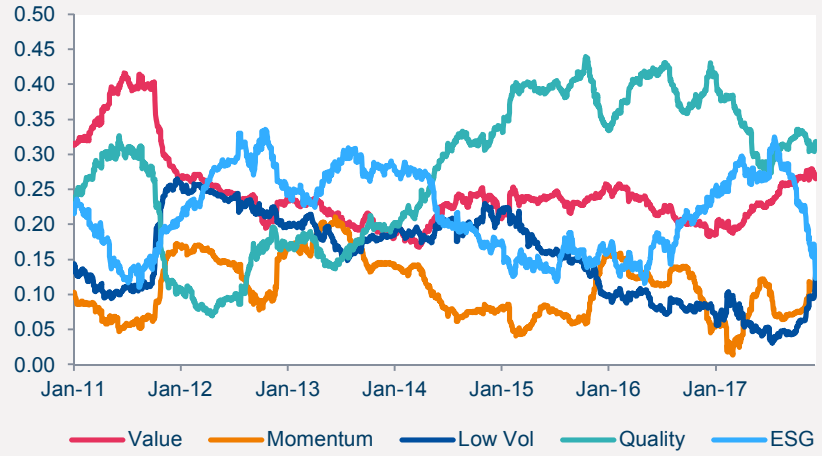
$$R_i = \alpha_i + \sum_{j=1}^{n_F} \beta_i^j F_j + \varepsilon_i \qquad \text{(a)}$$

where α_i is the intercept, β_i^j is the sensitivity of asset i to factor j, F_j is the (random) value of factor j and ε_i is the idiosyncratic risk. F_j can be one or a combination of long-only factors among size, value, momentum, low volatility, quality and ESG.

The redundancy of the information gives the ESG factor the status of new factor, facilitating risk management and, with the current trend toward more responsible investment, ensuring a certain level of returns. To assess the coherence of this new chimerical factor, we decided to loop back on tilting, which is a way to optimize portfolios using a global score constraint and minimizing the deviation toward global index, which are exposed quite regularly to common style factors. Tilting moderately favors highly rated assets over low-rated ones, while the ESG factor strictly focuses on best-in-class ESG quintile. Consequently, tilting an index increases its ESG factor exposure, and higher tilts lead to the portfolio's almost totally driven by this new factor.

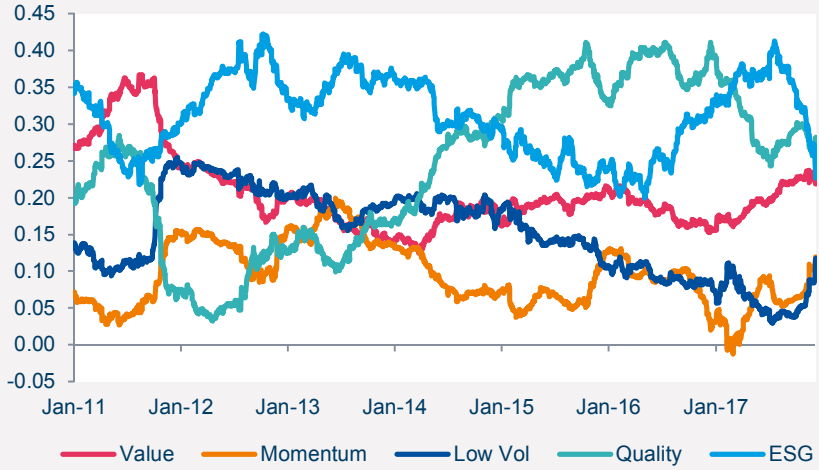
The relevance of this factor in concomitance with ESG tilt is demonstrated by Figures 75 to 78. This rolling study demonstrates that we can use ESG either as a constraint factor in an optimizer or as a chimerical equity factor.

Figure 75: MSCI World Index tilted 0.1



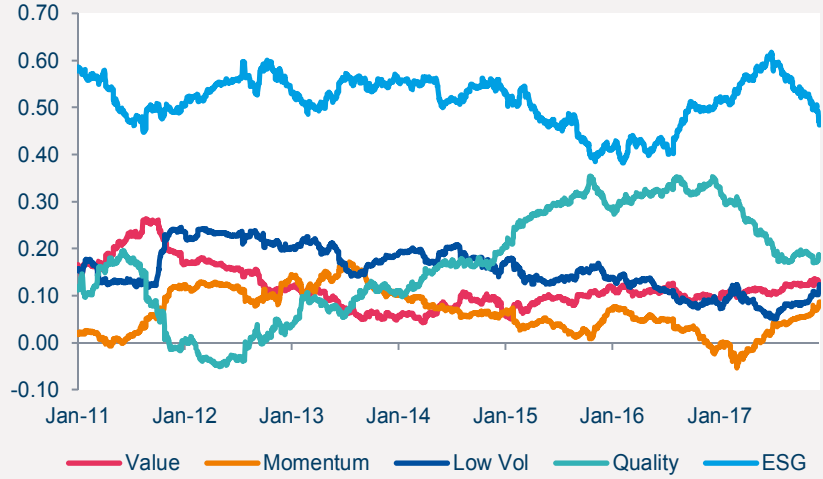
Source: Amundi Research

Figure 76: MSCI World Index tilted 0.5



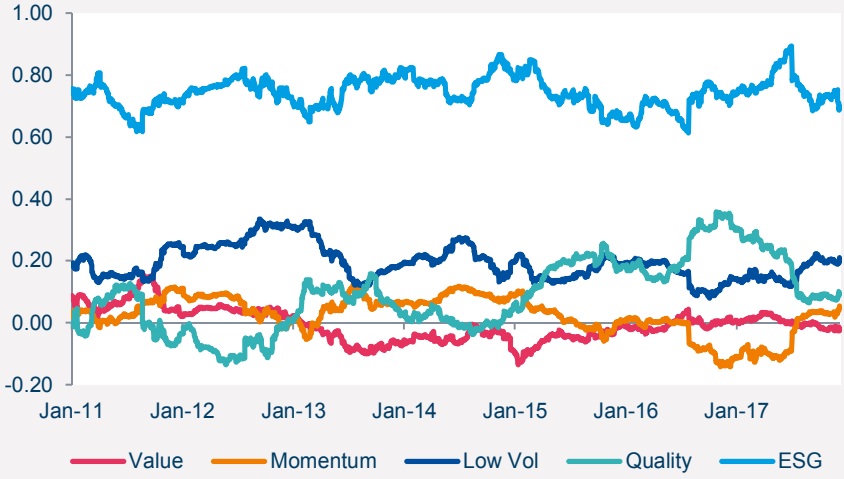
Source: Amundi Research

Figure 77: MSCI World Index tilted 1.0



Source: Amundi Research

Figure 78: MSCI World Index tilted 1.5



Source: Amundi Research

The tilt conserves some low volatility or quality exposure, depending on the period, which is caused by the correlations and overlays between factors. Extreme tilt (Figure 78) obviously focuses on the ESG best quintile and, hence, on the ESG equity factor.

V. Conclusion

This study aims to analyze the link between responsible practices and financial performances. It includes an analysis of the ESG global score, as well as ESG components, namely environmental, social and governance. As ESG data coverage and methodology are more consistent in last years, we chose to limit our study to 2010-to avoid producing non-robust results that do not reflect the financial market's current behavior. We analyze the impact of ESG integration on active management, passive management and factor investing strategies. In the active management process we use the sorted-based approach of Fama and French (1992) to identify the relationship between extra-financial scores and financial performances, in order to determine if this relation is risk-, return- or skewness-based. For passive management, we progressively enhanced the ESG global score using an optimization process to minimize the tracking error vs. benchmark and to analyze the impact in term of risk and return on optimal portfolios. We followed the same methodology on the environmental, social and governance

pillars. For the factor investing strategy, we tested the relevance of a new ESG factor. Each methodology is performed in different geographic regions to highlight the specificity of each area.

The results show that ESG integration in the equity markets evolved considerably during the period of 2010-2017. Focusing on two periods, 2010-2013 and 2014-2017, we observe a radical change in trend. In the first period, the impact of ESG integration on active or passive managers was neutral or slightly negative in both North America and the Eurozone in terms of performance, as well as drawdowns. In the second period, results are completely different in North America and Eurozone, showing that the pricing of ESG criteria is starting to be taken into account with a positive impact on performance and risks. Results are less conclusive for Europe ex-EMU and Japan. For Europe ex-EMU, ESG integration appears to be country specific. In Japan findings vary according to weighting schemes.

Considering the alpha generated by ESG investing, the increasing interest of the investors and the explanatory power of ESG on cross-section models, we can conclude that a new ESG factor is emerging in Eurozone. In a forward looking perspective, ESG may become a factor if the virtuous circle is fueled by investors. The questions that arise today in the Eurozone are: how to integrate this new factor in the diversification puzzle of factor investing and how to embed it in efficient management strategies?

Beyond the equity markets, more and more investors are incorporating extra-financial considerations into their portfolio strategies. Therefore, we expect an increasing attention towards political and environmental regulations, encouraging for immediate actions. The very encouraging results obtained in this study raise the question of the integration of ESG criteria in other asset classes, especially bonds. Can the results obtained on equity markets be applied to corporate and sovereign bonds? Is the contrast in ESG integration found in equity markets in terms of region, time and pillars similar to other asset classes? A next step would be to analyze the integration of ESG criteria in corporate and sovereign bonds and to determine if this universe is starting to price extra-financial criteria. Is there a risk premium in investing on highly ESG rated or green bonds? What is the impact of ESG on credit ratings? Research results have been mixed, Shi and Sun (2015) revealed that “socially responsible bond funds outperform by one-half of one percent annually”, while Menz (2010) showed that the pricing of corporate bonds haven’t incorporated extra-financial criteria yet.

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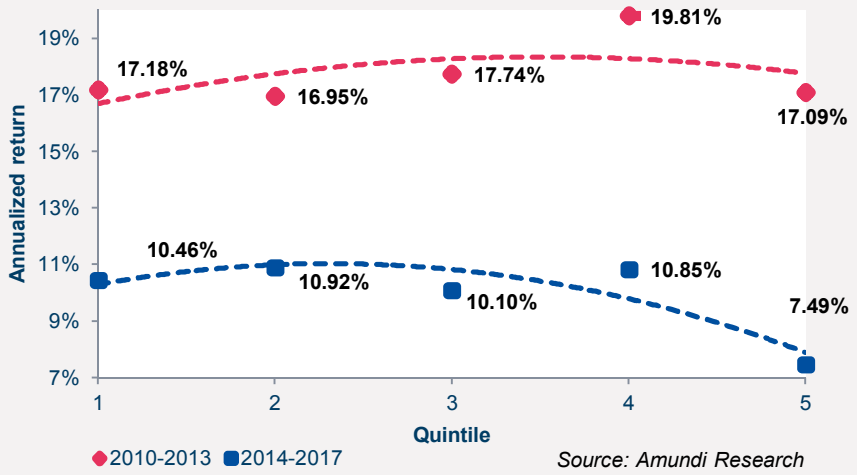
Appendix

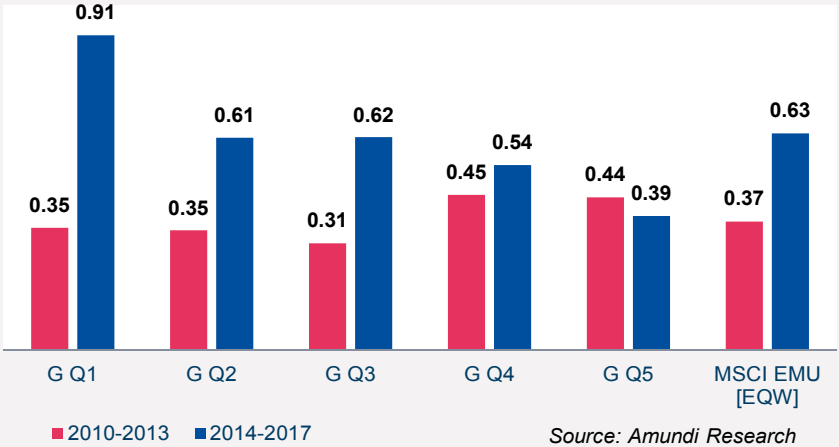
Appendix A: Performance of ESG investing

Figure 1: Governance quintiles returns and trend [MSCI North America]



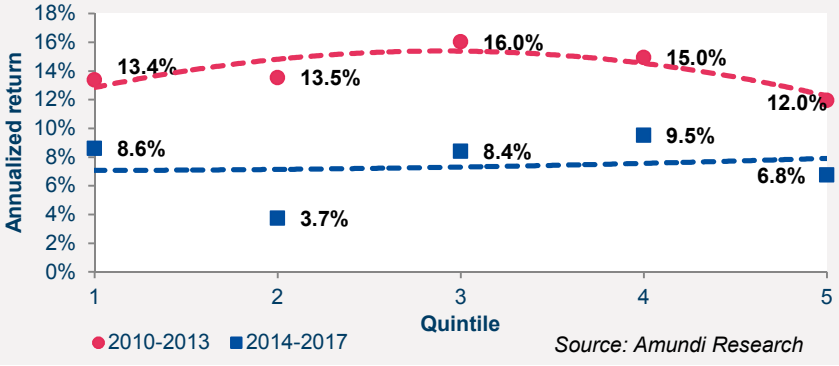
Source: Amundi Research

Figure 2: Governance pillar quintile adjusted returns [MSCI EMU]



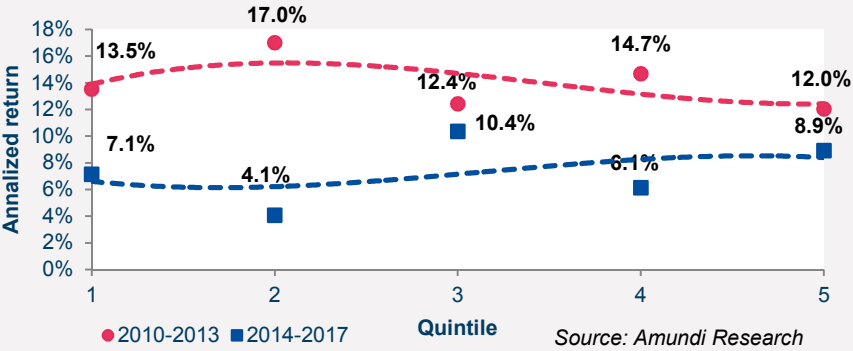
Source: Amundi Research

Figure 3: ESG performance of sorted portfolios [MSCI Europe Ex-EMU]



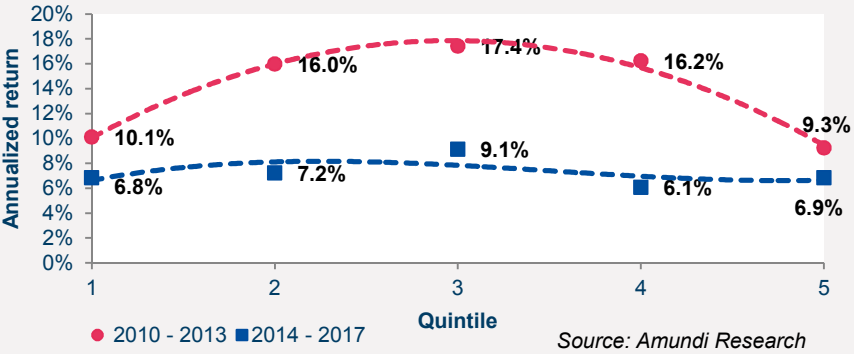
Source: Amundi Research

Figure 4: E performance of sorted portfolios [MSCI Europe Ex-EMU]



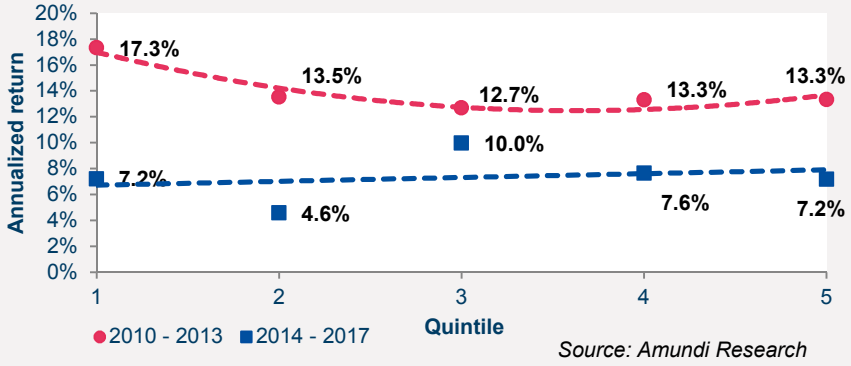
Source: Amundi Research

Figure 5: S performance of sorted portfolios [MSCI Europe Ex-EMU]



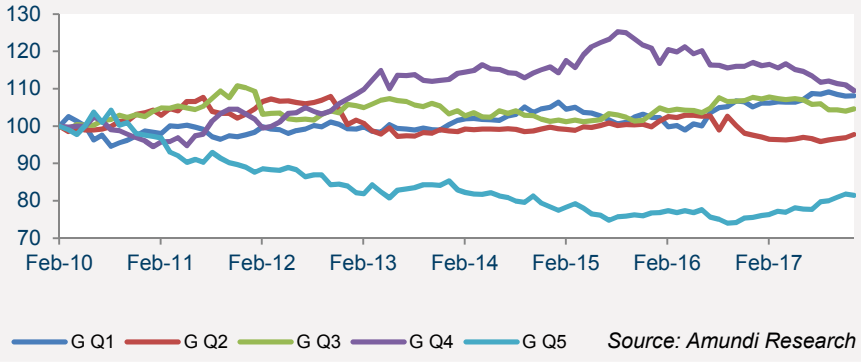
Source: Amundi Research

Figure 6: G performance of sorted portfolios [MSCI Europe Ex-EMU]



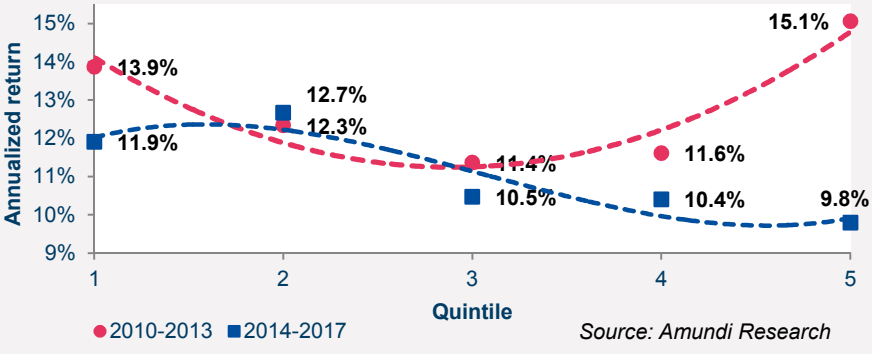
Source: Amundi Research

Figure 7: Japan market-cap weighted governance quintiles



Source: Amundi Research

Figure 8: Environmental quintiles returns and trend [Japan]



Source: Amundi Research

Figure 9: Governance quintiles returns and trend [Japan]

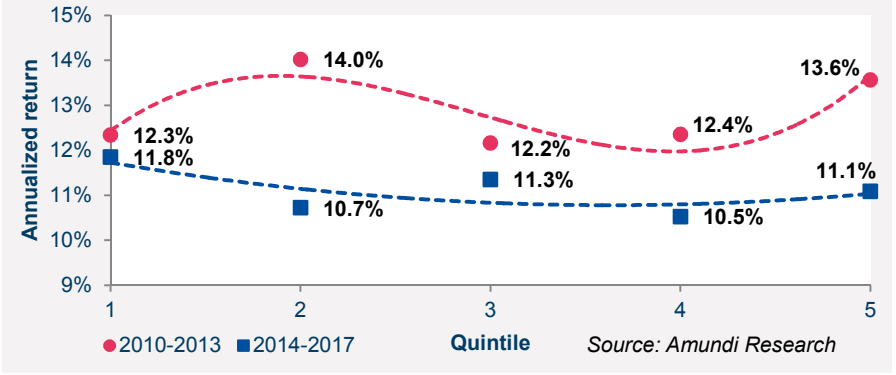
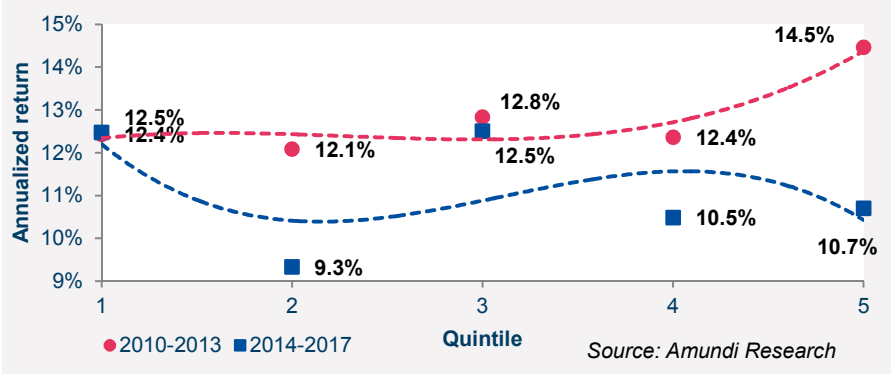
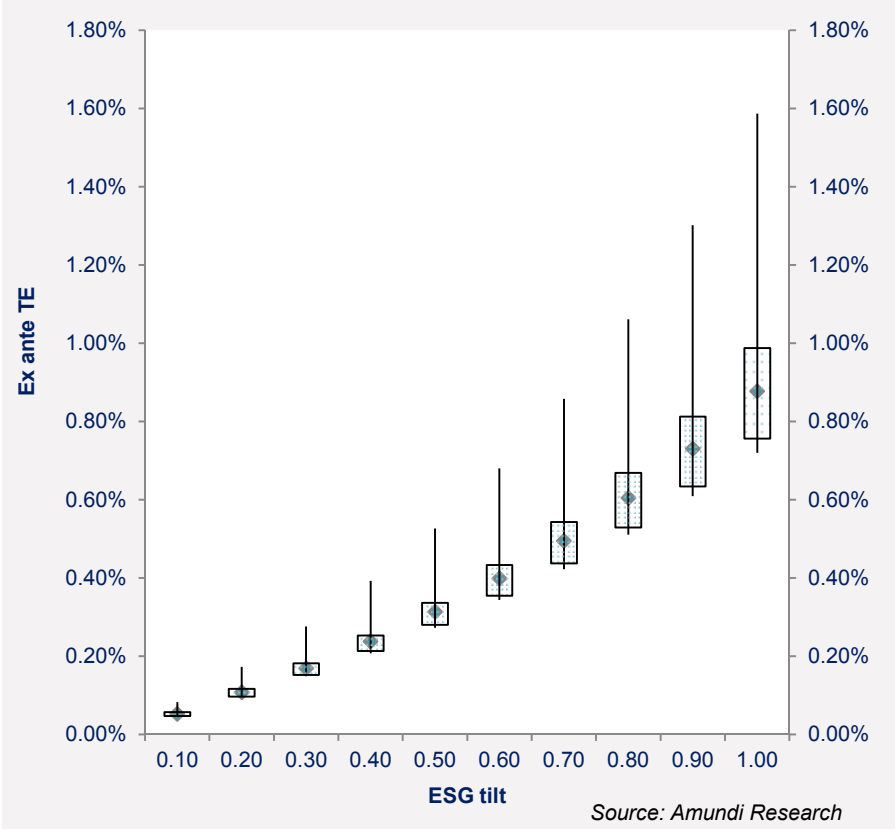


Figure 10: Social quintiles returns and trend [Japan]



This graph demonstrates higher volatility of the constrained portfolio as it focuses on a smaller range of securities. Consequently, confidence intervals of ex-ante tracking error widen with the tilt.

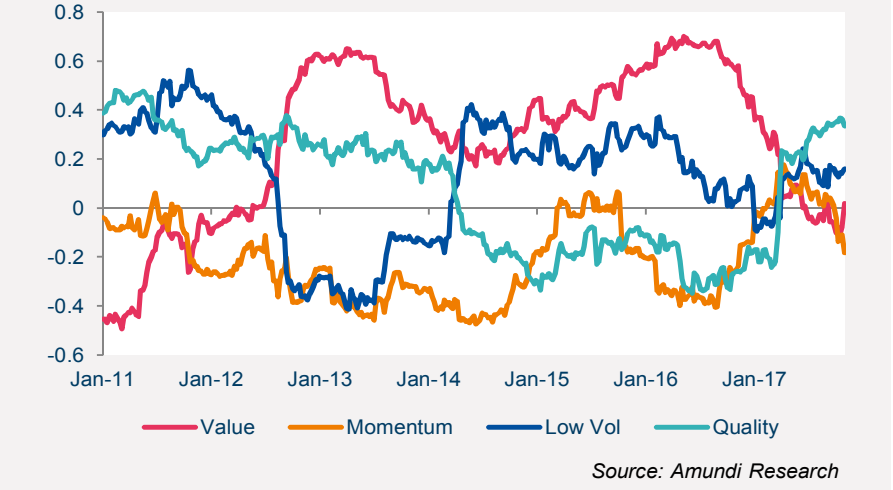
Figure 11: TE confidence intervals



Source: Amundi Research

Appendix B:
Further Multi-Factor Analyses

Figure 1: ESG Q1
Moving 1Y correlation of excess returns vs. MSCI North America



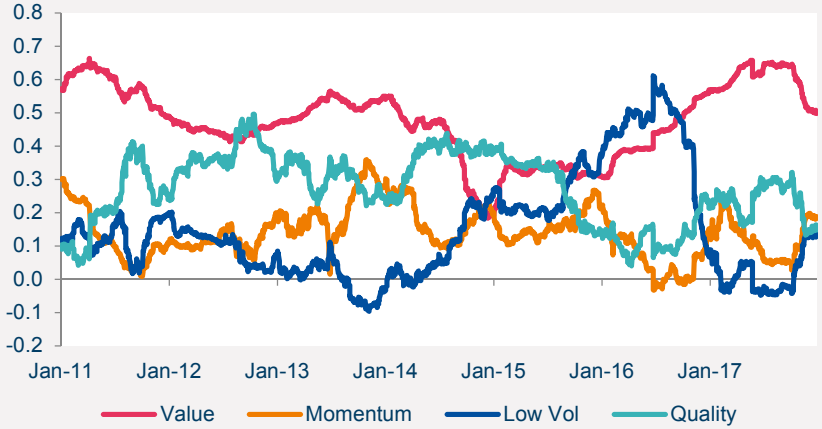
Source: Amundi Research

Table 1: Average 4-year correlations of excess returns [North America]

2010 2013	*Value*	*Momentum*	*Low Volatility*	*Quality*	*ESG*
Value	100%				
Momentum	-17.32%	100%			
Low Volatility	-48.08%	-36.65%	100%		
Quality	-22.90%	3.37%	-0.04%	100%	
ESG	18.98%	-17.32%	-48.08%	-22.90%	100%

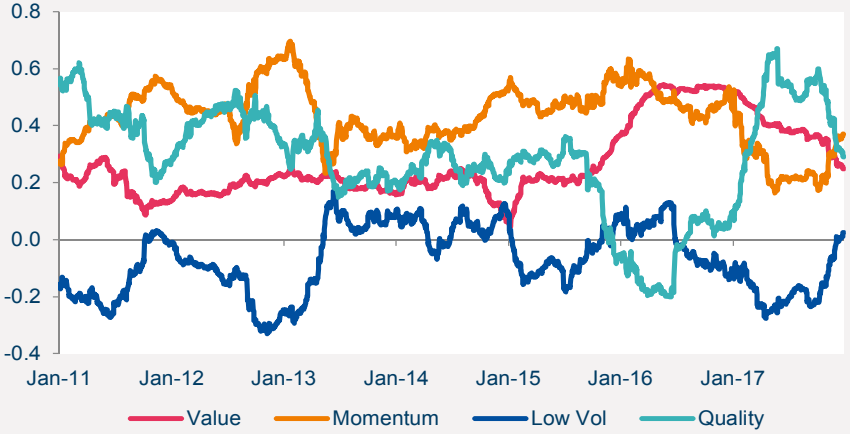
2014 2017	*Value*	*Momentum*	*Low Volatility*	*Quality*	*ESG*
Value	100%				
Momentum	-44.73%	100%			
Low Volatility	-23.74%	17.80%	100%		
Quality	-42.22%	17.25%	-11.74%	100%	
ESG	41.21%	-44.73%	-23.74%	-42.22%	100%

Figure 2: EMU time variant factor exposures – E Q1



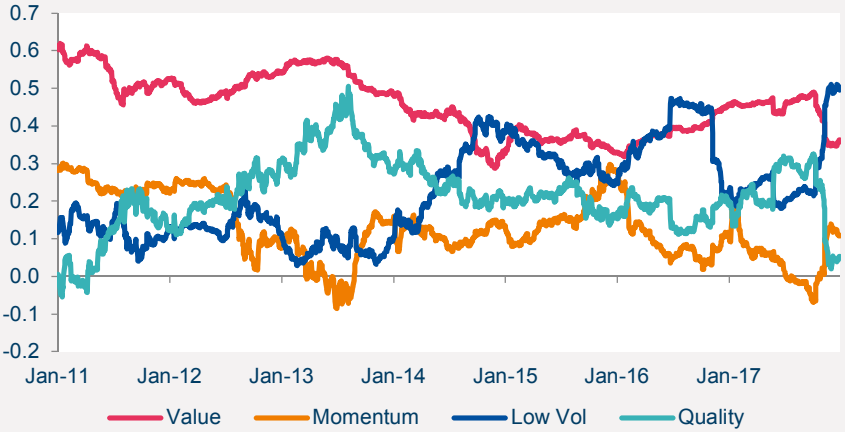
Source: Amundi Research

Figure 3: EMU time variant factor exposures – E Q5



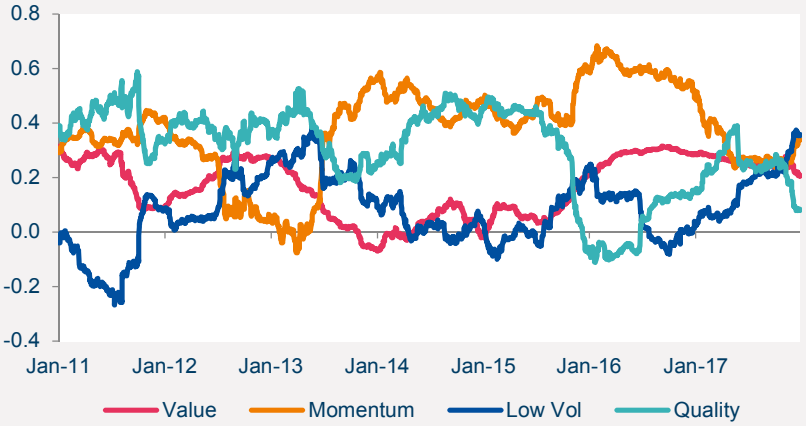
Source: Amundi Research

Figure 4: EMU time variant factor exposures – S Q1



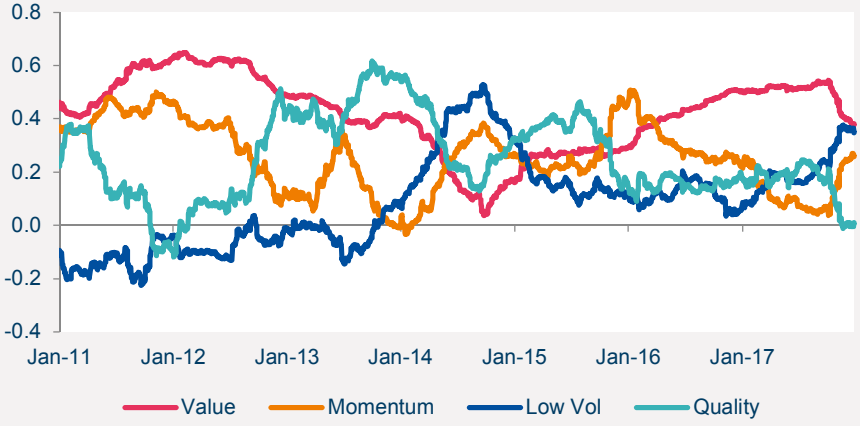
Source: Amundi Research

Figure 5: EMU time variant factor exposures – S Q5



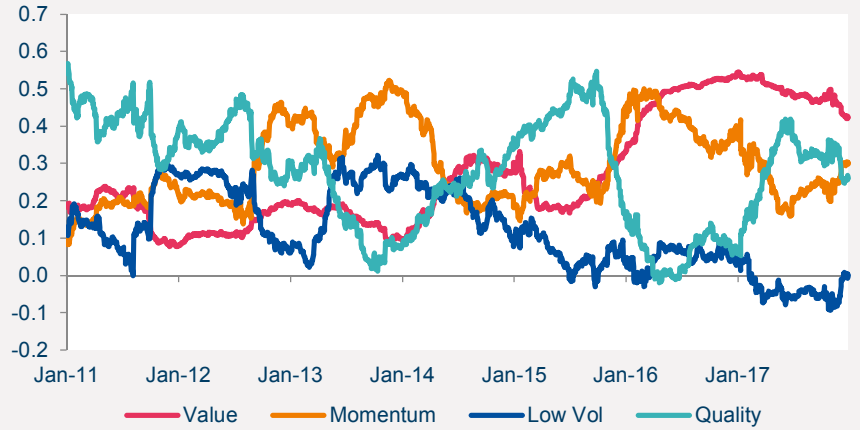
Source: Amundi Research

Figure 6: EMU time variant factor exposures – G Q1



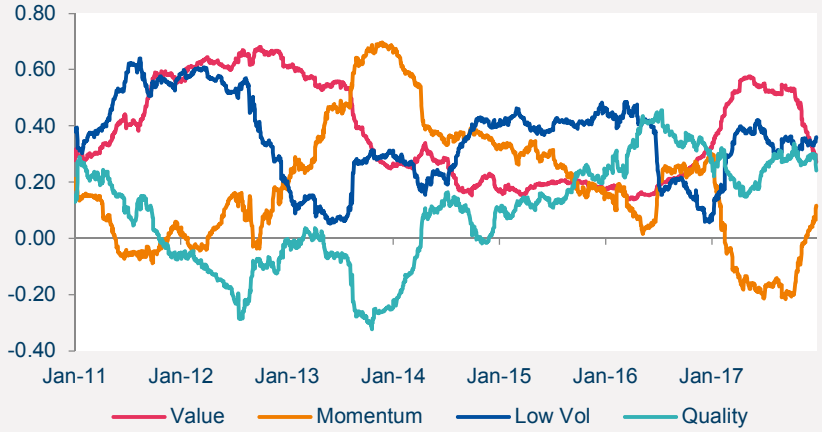
Source: Amundi Research

Figure 7: EMU time variant factor exposures – G Q5



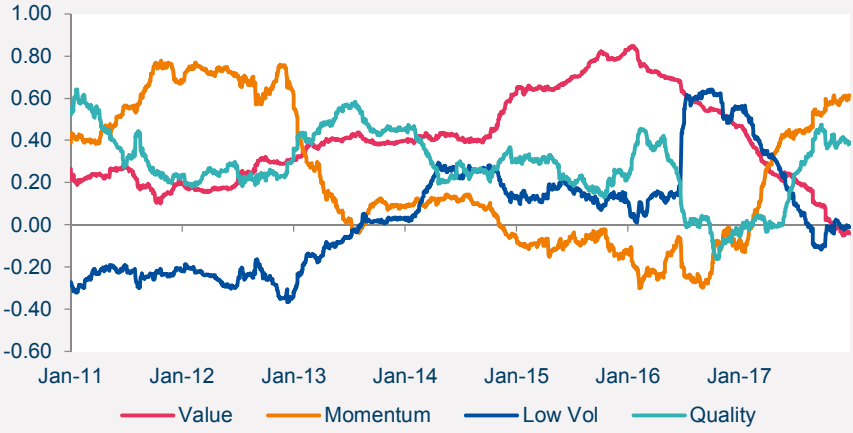
Source: Amundi Research

Figure 8: Europe ex-EMU time variant factor exposures – E Q1



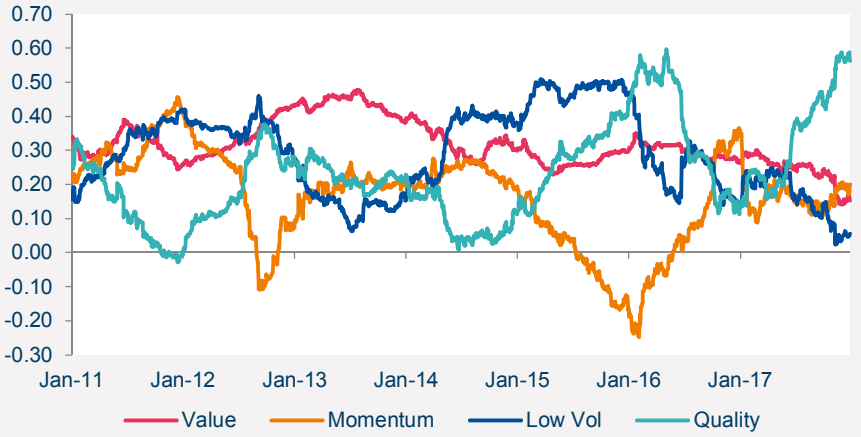
Source: Amundi Research

Figure 9: Europe ex-EMU time variant factor exposures – E Q5



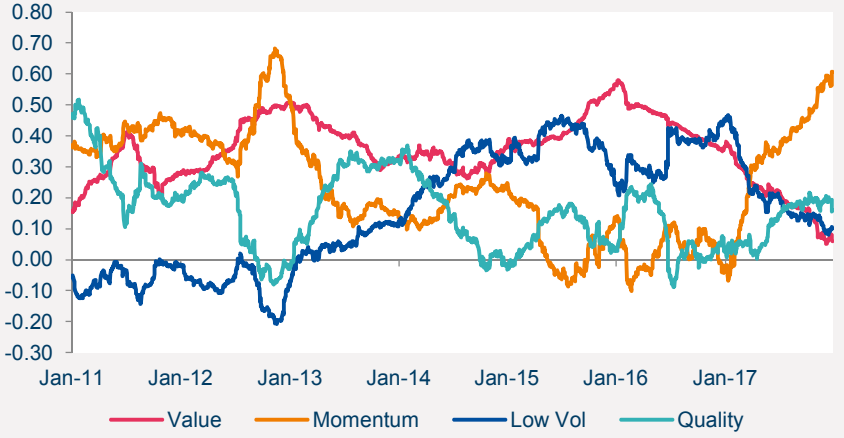
Source: Amundi Research

Figure 10: Europe ex-EMU time variant factor exposures – S Q1



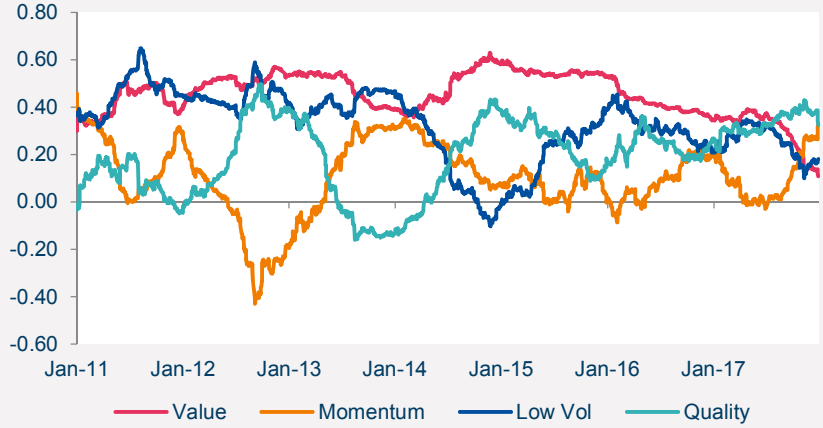
Source: Amundi Research

Figure 11: Europe ex-EMU time variant factor exposures – S Q5



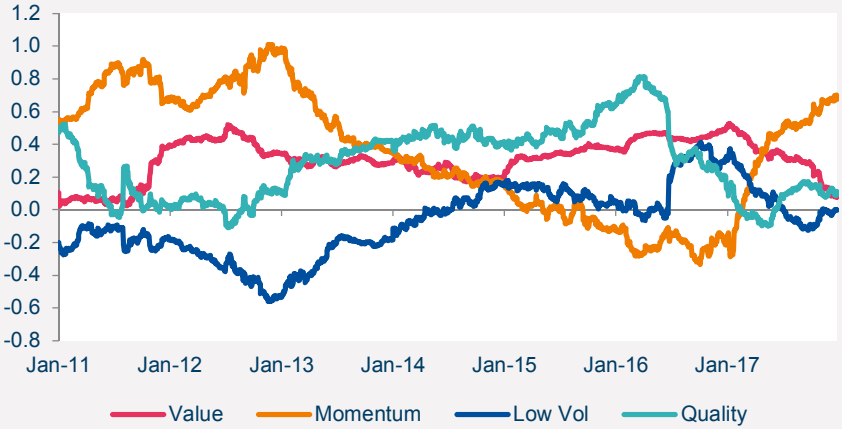
Source: Amundi Research

Figure 12: Europe ex-EMU time variant factor exposures – G Q1



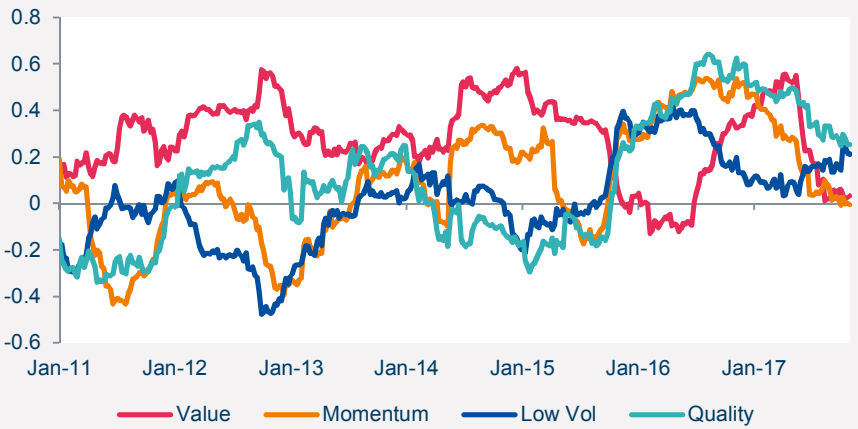
Source: Amundi Research

Figure 13: Europe ex-EMU time variant factor exposures – G Q5



Source: Amundi Research

Figure 14: ESG Q1
Moving 1Y correlation of excess returns vs. MSCI Europe ex-EMU



Source: Amundi Research

Table 2: Average 4-year correlations of excess returns [Europe ex-EMU]

2010 2013	*Value*	*Momentum*	*Low Volatility*	*Quality*	*ESG*
Value	100.00%				
Momentum	14.60%	100.00%			
Low Volatility	-73.91%	-29.50%	100.00%		
Quality	-4.46%	28.40%	8.31%	100.00%	
ESG	29.64%	3.08%	-13.64%	-1.99%	100.00%

2014 2017	*Value*	*Momentum*	*Low Volatility*	*Quality*	*ESG*
Value	100.00%				
Momentum	-23.92%	100.00%			
Low Volatility	-58.63%	46.56%	100.00%		
Quality	-31.47%	69.27%	52.26%	100.00%	
ESG	21.68%	29.38%	15.80%	29.34%	100.00%

Table 3: Average 4-year correlations of excess returns [Japan]

2010 2013	*Value*	*Momentum*	*Low Volatility*	*Quality*	*ESG*
Value	100%				
Momentum	-45%	100%			
Low Volatility	-38%	34%	100%		
Quality	-41%	53%	72%	100%	
ESG	44%	-18%	-49%	-22%	100%

2014 2017	*Value*	*Momentum*	*Low Volatility*	*Quality*	*ESG*
Value	100%				
Momentum	-74%	100%			
Low Volatility	-50%	42%	100%		
Quality	-76%	69%	54%	100%	
ESG	38%	-34%	-42%	-27%	100%

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December 2018 | Working Paper

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