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Integrating ESG in Factor-based Investing in Sovereign Bond Markets: A Size Approach

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Abstract

The group report analyses the joint impact of Momentum, Value, Size, and Low Volatility in factor-based investing in sovereign bond emerging and developed markets, develops an ESG factor, and assesses its effects across several strategies. This individual report focuses on a Size approach and finds that the total value of government debt can be used to achieve higher risk-adjusted returns. Across the 13 years of data, the results show that ESG scores have little impact on top of the Size factor. This new integrated approach to sovereign bond markets adds to the recent and increasing literature on ESG investing.

Keywords

Finance; Financial Markets; Data Analysis; ESG; Factor-based Investing; Sovereign Bond Markets; Size

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1. Introduction and Literature Review

This report examines the impact of ESG and Size in the performance of factor-based investment strategies. The universe of securities analyzed comprises sovereign bonds from countries in emerging and developed markets, with a dataset of about 115,000 bond-month observations from 2009 to 2021. A separate analysis will be conducted for each of those two markets, as well as a third one that combines both.

There is no doubt that the sovereign bond market is a major asset class, being essential for governments worldwide to satisfy their capital needs and continue to perform their functions properly. It has grown by roughly 58% during the 13 years of our sample and, at the end of the third quarter of 2021, it represented about 20% of the total debt outstanding worldwide, amounting to more than $60 trillion.

However, even though Size is a well-known factor in finance mainly due to the works of Banz (1981) and Fama and French (1992) in equities, its literature in credit markets is still relatively scarce, especially in the sovereign bond market. Houweling and Zundert (2016) included Size when applying factor investing to the U.S. corporate bond market, as did Dekker, Houweling, and Muskens (2019) when showing new evidence of factor investing in corporate bonds of emerging markets. More recently, Baltussen, Martens, and Penninga (2021) examined global sovereign bond factor premiums but did not include Size in their analysis.

Besides, the integration of ESG (Environmental, Social, and Governance) standards in factor-based investing is a relatively recent topic. To date, it is still scarcely documented in scientific literature, as most research is being conducted by enterprises to be included in their proprietary models. Due to its intrinsic qualitative characteristics, the integration of ESG in quantitative investing poses some challenges. Chen and Mussalli (2020) and Chen, Mussalli, and Mahdavi (2020) highlight the current lack of standardization and the dependence on

subjective data inputs. Mainly, we need to consider not only which aspects and topics to include in the ESG factor but also their relative importance (also known as "materiality"). Optimally integrating both financial and non-financial objectives in a portfolio without threatening alpha is also one of the main challenges.

2. Size and ESG as useful predictors of sovereign bonds' returns and risk

The size premium, also known as the small-firm effect or the SMB factor (Small Minus Big) in Fama-French factor models, generally refers to an apparent anomaly in equity markets: stocks with smaller market capitalizations tend to deliver higher risk-adjusted returns than large-capitalization stocks. The economic rationale behind this can be linked to several reasons. On one hand, smaller firms generally have more growth opportunities than larger firms (usually more stabilized), making them better positioned to capture market share from their competitors. Additionally, due to their more volatile business environment, smaller companies have a greater scope to correct structural deficiencies. Their less diversified businesses allow for more efficient capital allocation to growth opportunities, and their leaner setups make them more able to respond to changing market dynamics more quickly. So far, these arguments point to higher future price appreciation. On the other hand, the size premium can also be justified by being a reward for investors taking additional risk when it comes to transaction reasons, as small-capitalization stocks are usually more illiquid and expensive to trade than larger capitalization stocks. Finally, from a behavioral point of view, it is also argued that smaller firms are usually overlooked due to a lack of investor recognition and research available, which underestimates their worth and return potential.

The size factor is less common in bond markets than in equity markets, as the literature on it is not only less in quantity, but also not as empirically conclusive as in stocks. Nevertheless, it can still be very interesting to analyze whether the size factor can be used to achieve higher

risk-adjusted returns in credit markets, especially in sovereign bonds since most research is focused on corporate debt.

At this point, we need to define what the best proxy for "size" is in the context of sovereign bonds. Using the equity market as a starting point, the size measure is the total market capitalization of a company, which is given by the market value of all its outstanding shares. Similarly, the size measure that will be used in this report is the total market value of a sovereign's outstanding debt, which is commonly known as Public Debt or Government Debt. It could also be argued that a better proxy would be the total size of the government – measured by its revenue and/or expenditures – or even the total size of the country – measured by its Gross Domestic Product (GDP). However, as in stocks we are analyzing equity returns, here we are analyzing debt returns, and so it is more rational to use total public debt. Moreover, when applying the size factor to corporate bonds, most researchers use the company's total outstanding debt as a size proxy, which is analogous to this report's approach.

Ultimately, this means that we will analyze and test whether the sovereign debt returns of countries with smaller total public debts outperform the returns from higher ones. Notwithstanding, the economic meaning of that test must be discussed *a priori*: why can the size of a sovereign be a useful predictor of its public debt's risk and returns? To answer this question, two cases have to be considered.

The first case is to acknowledge that the sovereigns exhibiting lower values of absolute total public debt within the overall sample are the ones with smaller public debt burdens. Here, the lower percentage of public debt to GDP translates into less credit default risk. Since the proportion of wealth being generated to guarantee the repayment of the debt is higher than otherwise, that debt is less risky from an investor standpoint. On top of that, if the country is also big (in terms of GDP), its bonds are likely to be more liquid, which makes it even less

risky. Moreover, a government that is not constrained by high debt obligations has wider means of taking advantage of economic growth and development opportunities.

The second case is the special instance of small countries with high public debt burdens. Within our sample, they can also be considered small in terms of the size factor because their absolute value of public debt is still comparatively lower. Bonds from smaller countries tend to be less liquid than those from bigger countries, which makes room for investors to capture some illiquidity premium. Less liquidity in a market usually translates into more price discrepancies, which can be exploited by investors as arbitrage opportunities, for example. This way, smaller countries' debt can also provide higher risk-adjusted returns, even after considering their potential increased credit risk (due to their higher debt burden).

Furthermore, it is important to discuss what ESG is and why it can also be a useful predictor of public debt risk and return. ESG stands for Environmental, Social, and Governance, and it is a set of standards that socially conscious investors usually use to evaluate companies and to screen potential investments. Currently, these criteria are far from being consensual and their inherent subjectivity is a challenge to standardization.

Besides, one might think that using non-financial factors to build investing strategies can be a threat to the maximization of risk-adjusted returns. Even though this sometimes may be the case when those factors restrict the universe of investments, there are reasons to believe that incorporating ESG concerns in investment decisions can ultimately benefit alpha and risk-adjusted returns. The argument is that an enterprise or government that worries about the environment, is socially responsible, and promotes good governance practices has better growth opportunities and poses less financial risk in the future than a company or sovereign that otherwise does not care for ESG standards. See, as corporate-level examples, the cases of Volkswagen's carbon emissions scandal of 2015 (Environmental), BBC's gender pay gap controversy of 2017 (Social), and Enron's accounting fraud scandal of 2001 (Governance). All

these companies' reputation was severely hit and their financial health was compromised – Enron even had to file for bankruptcy.

More recently, and as a government-level example, recall the boycott of the 2022 FIFA World Cup in Qatar by some national football federations due to the alleged persistence of human rights abuse in that country. Denmark's federation was the first to announce that it "will minimize the number of trips to the country [Qatar] to avoid commercial activities that promote the World Cup hosts' events" and that their "training-kit sponsors will make way for messages critical of Qatar". This is a clear example of negative consequences in terms of divestment and capital outflows from a country that struggles mainly with Social and Governance problems, which can repel ESG-minded investors and potentially pose greater future financial risk.

3. Data

The bond data comes from two ETFs. For the emerging markets (EM) data, the basis was the Invesco Emerging Markets Sovereign Debt ETF (PCY), which follows the DBIQ Emerging Market USD Liquid Balanced Index. For the developed markets (DM) data, the basis was the iShares International Treasury Bond ETF (IGOV), which tracks the FTSE World Government Bond Index Developed Markets Capped Select Index.

These ETFs' holdings and respective monthly prices were extracted from Bloomberg, from May 2009 to October 2021 (150 months). Those holdings correspond exclusively to fixed-rate sovereign bonds i.e. bonds that are fully backed and guaranteed by the government. To facilitate comparisons all prices are denominated in USD.

Even though government defaults are rarer and conceptually different than corporate defaults, the survivorship bias is not present in the dataset. Every month, bonds can enter or leave the

sample and whenever a country defaults, their bonds' returns are based on the final trading price, which usually reflects the expected recovery rate.

The PCY ETF has data from 53 emerging markets' governments and 280 bonds, while the IGOV ETF provides data from 23 developed markets' countries and 1495 bonds. Since South Korea was present in both ETFs, we removed its bonds from the developed markets' sample, leaving us with 1437 bonds from 22 countries.

The data concerning size was extracted from the CEIC worldwide database. For every country belonging to the two aforementioned ETFs, we extracted its total public debt in USD for every month in the sample. Due to the lack of standardized public debt data, 12 emerging markets' governments were excluded from the initial sample, which gives a final total of 1662 bonds from 63 sovereigns.

In terms of the ESG factor, country-level ESG scores are needed for each of the three markets: emerging, developed, and both combined. As explained in the group report, we based our computations on a methodology from financial data provider Refinitiv and were able to compute ESG numerical scores ranking all countries within each of the three sample markets, which will be used in this report as well.

A distinction between credit ratings will be useful in the performance analysis. This data, which was also extracted on a monthly frequency from Bloomberg, consists of the Bloomberg Default Risk Scale, which divides each sovereign into 3 main categories: IG (Investment-Grade), HY (High-Yield), or DS (Distressed).

4. Methodology and strategy

Several strategies will be tested in this report for the three markets (emerging, developed, and both). The main division is between Long-Short and Long-Only portfolios. These two will then

be subdivided into another two portfolios according to the credit ratings. Finally, the ESG scores are introduced to compare all portfolios with and without the ESG factor and analyze its impact on performance statistics. Remember that size is defined as the total public debt of a country, and so the analysis from here onwards will be conducted at country level. Thus, for every month, each country will have a return that comes from a simple average of its available bonds' arithmetic returns.

Firstly, the signal construction starts with the credit rating division: whenever a portfolio is grouped by credit rating, the monthly signal is "1" for that category and "0" for the remaining. For a more complete explanation, we refer the reader to the group report.

Secondly, to apply the size factor we start by computing the median of the total public debt from those countries whose signal is different than zero. Then – and according to the Small Minus Big rationale explained previously –, for every month in both Long-Short and Long-Only portfolios, if a country's total public debt is below that median, we go long on that country's returns in the following month (signal = 1). For those countries whose total public debt is above that median, in the Long-Short portfolios we go short on the following month's return (signal = -1), while in the Long-Only portfolios we do not consider them (signal = 0). Note that the current month's signal is applied to next month's returns to avoid the forward-looking bias – for a given date, we cannot use total public debt information that we only know on that same date.

Thirdly, the ESG factor is included by dividing the dataset into quartiles. So, for Long-Short portfolios, we go long on the top quartile and short on the bottom quartile. For Long-Only portfolios, we only go long on the top quartile.

Finally, all countries are equally weighted. There was the alternative of weighting them by size, but that way the size effect would be present in two different ways (through the median and the

weights), which could distort the fundamentals of the analysis. Thus, the total weight of Long-Short strategies is equal to zero, as the short side's weight shadows the ones from the long side, while the total weight of Long-Only strategies is one.

5. Empirical results

This section presents the main results and conclusions from the strategies. In terms of performance comparisons, after presenting the two benchmarks we analyze the more theoretical Long-Short portfolios and then we will look at the more practical Long-Only ones. Even though assessing the feasibility of implementing these portfolios is not the main scope of this report, it is important to point out that many sovereign bonds cannot be shorted, and even if they can, it can be costly and more complex, especially in the emerging markets segment. Thus, investors looking to implement these Long-Short portfolios need to be aware that, as presented below, they may not reflect realistic investment opportunities, as higher transaction costs can compromise returns. To overcome that drawback, Long-Only portfolios are recommended.

Benchmarks

The Invesco Emerging Markets Sovereign Debt ETF, which is the benchmark for the emerging markets portfolios, yielded an annualized return of 0.77% and a Sharpe ratio of 0.08 from May 2009 to October 2021. On the other hand, the developed markets' benchmark, which is the iShares International Treasury Bond ETF, yielded an annualized return of 0.05% and a Sharpe ratio of 0.01 for the same period. This means that, unsurprisingly, sovereign bonds in emerging markets performed better than in developed markets. The vast majority of our developed markets' sovereigns consists of European countries and our sample covers the Eurozone Sovereign Debt Crisis and its aftermath, a period marked by easing monetary policies that resulted in extremely low and even negative interest rates. Thus, fixed income investors found better opportunities in emerging markets, thus making their sovereign bonds more attractive.

Long-Short portfolios

The inclusion of the size factor improved the performance in both markets. Not only the returns were higher, but also the volatility decreased (as seen in Exhibit 1), leading to better Sharpe ratios than those from the benchmarks. In emerging countries, it went from 0.08 to 0.27, while in developed countries from 0.01 to 0.18. This points to some degree of relevance regarding the significance of size.

However, the separation by credit ratings yielded opposite results. While in emerging markets the portfolios remained relatively similar and continued to outperform the benchmark, in developed markets the separation was not beneficial. Introducing the size factor while controlling for credit risk in countries where that risk is almost insignificant is detrimental.

Exhibit 1: Performance statistics of the Long-Short portfolios in Emerging and Developed Markets without integrating the ESG factor

Emerging Markets	Benchmark	All	IG	HY
Annualized Return	0.77%	0.84%	0.57%	1.41%
Annualized Volatility	9.69%	3.13%	3.59%	5.12%
Shape ratio	0.08	0.27	0.16	0.28
Developed Markets	**Benchmark**	**All**	**IG1-5**	**IG6-10**
Annualized Return	0.05%	0.44%	-0.39%	-0.55%
Annualized Volatility	7.32%	2.45%	2.81%	5.95%
Shape ratio	0.01	0.18	-0.14	-0.09

The introduction of the ESG factor in Long-Short portfolios does not improve their performance. While in emerging countries the annualized return goes negative, in developed countries it improves, but at the expense of a greater increase in volatility. In fact, the ESG factor almost doubles volatility across the portfolios. The rationale is that by restricting the investment universe of bonds available to invest in, the ESG factor concentrates the same total weight on fewer bonds, which makes the overall volatility more reactive to comparatively smaller changes in each bond's individual standard deviation. As usually, less diversification

corresponds to more risk. The most relevant impact on the overall performance of the ESG factor is on the developed markets' portfolio for the worst-rated countries (between IG6 and IG10), on which the substantial increase in returns leads to a Sharpe ratio of 0.41 – the highest thus far. In this case, when controlling for some credit risk, the size and ESG factors combined deliver higher risk-adjusted returns.

Exhibit 2: Performance statistics of the Long-Short portfolios with the ESG factor in Emerging and Developed Markets

Emerging Markets	**Benchmark**	**All**	**IG**	**HY**
Annualized Return	0.77%	-0.30%	0.95%	0.87%
Annualized Volatility	9.69%	5.94%	5.49%	8.67%
Shape ratio	0.08	-0.05	0.17	0.10
Developed Markets	**Benchmark**	**All**	**IG1-5**	**IG6-10**
Annualized Return	0.05%	0.66%	-0.73%	2.81%
Annualized Volatility	7.32%	4.73%	5.75%	6.88%
Shape ratio	0.01	0.14	-0.13	0.41

Long-Only portfolios

The more practical Long-Only portfolios yielded generally better results than the more theoretical Long-Short portfolios. Introducing the size factor, and thus focusing on investing solely in countries with smaller total public debts, presented considerably higher risk-adjusted returns in both emerging and developed markets, with Sharpe ratios of 0.31 and 0.34, respectively. However, as expected, the emerging markets' portfolio reached that with more volatility. Again, the results point to some degree of significance of the size factor in Long-Only strategies.

Moreover, here the separation by credit ratings is not detrimental. In fact, the worst-rated countries from both markets exhibit better performance results than the rest, which points to some risk premium from riskier countries. This highlights once more the effectiveness of size

and ESG in the sample of worst-rated countries when controlling for some degree of credit risk in Long-Only portfolios.

Exhibit 3: Performance statistics of the Long-Only portfolios in Emerging and Developed Markets without integrating the ESG factor

Emerging Markets	Benchmark	All	IG	HY
Annualized Return	0.77%	2.12%	1.35%	2.95%
Annualized Volatility	9.69%	6.80%	6.45%	7.80%
Shape ratio	0.08	0.31	0.21	0.38
Developed Markets	**Benchmark**	**All**	**IG1-5**	**IG6-10**
Annualized Return	0.05%	1.32%	1.20%	2.67%
Annualized Volatility	7.32%	3.82%	3.39%	6.32%
Shape ratio	0.01	0.34	0.35	0.42

While the inclusion of the ESG factor had little impact on the performance measures of the emerging countries' sample, it unilaterally decreased the returns of the developed countries' portfolio, resulting in a decrease of the Sharpe ratio from 0.34 to 0.13. Additionally, there were slight improvements in the performance of the emerging markets' portfolios separated by credit ratings. However, once again the best-performing portfolio is composed of the worst-rated developed countries (IG6 to IG10), with the highest annualized returns (4.06%) and Sharpe ratio (0.51). Recall that this is also verified in the Long-Short sample of results.

Exhibit 4: Performance statistics of the Long-Only portfolios with the ESG factor in Emerging and Developed Markets

Emerging Markets	Benchmark	All	IG	HY
Annualized Return	0.77%	1.73%	1.41%	3.34%
Annualized Volatility	9.69%	5.74%	5.34%	7.85%
Shape ratio	0.08	0.30	0.26	0.43
Developed Markets	**Benchmark**	**All**	**IG1-5**	**IG6-10**
Annualized Return	0.05%	0.48%	0.60%	4.06%
Annualized Volatility	7.32%	3.64%	3.45%	7.97%
Shape ratio	0.01	0.13	0.17	0.51

Combining emerging and developed markets

Lastly, the returns, the total public debt, the ESG scores, and the credit ratings of both emerging and developed countries were combined into one single sample, in which new ESG percentile scores were computed to account for all countries at once.

Starting again with the Long-Short portfolios, the combined strategy did not benefit from diversification benefits among the two markets after the introduction of the size factor, which can partially be explained by the positive correlations (although weak) between the returns of emerging and developed countries. We can also conclude that the size factor works best when controlling for the type of market. Besides, since most HY-rated countries belong to the emerging market's sample, the remarkable performance of the combined HY portfolio reflects the good performance of the HY sample of only emerging markets (Exhibit 1 above).

Moreover, including the ESG factor makes the Sharpe ratio of the combined portfolio (0.10) an approximated average of the emerging (-0.05) and developed (0.14) portfolios (Exhibit 2 above), which is in line with their near-zero negative correlation. The ESG factor in the separated credit ratings' portfolios was detrimental to both groups, mirroring what happened in the emerging and developed markets' individual samples.

Exhibit 5: Performance statistics of the Long-Short combined portfolios without and with the ESG factor

Without the ESG factor	**All**	**IG**	**HY**
Annualized Return	0.16%	-0.71%	2.75%
Annualized Volatility	3.64%	3.66%	5.22%
Shape ratio	0.04	-0.19	0.53
With the ESG factor	**All**	**IG**	**HY**
Annualized Return	0.42%	-0.79%	0.44%
Annualized Volatility	4.04%	3.29%	8.94%
Shape ratio	0.10	-0.24	0.05

Finally, the Long-Only combined strategies presented better results than the Long-Short ones, similar to what happened in the individual samples. Notwithstanding, the performance was not as good as in the emerging and developed markets alone (Exhibit 3 above), which once again suggests that size works best when controlling for the type of market.

However, although slightly, here the introduction of the ESG factor improves the performance of all portfolios, which can be attributed to the ESG rankings' improvement – through the percentile scores – when considering all countries simultaneously.

Exhibit 6: Performance statistics of the Long-Only combined portfolios without and with the ESG factor

Without the ESG factor	**All**	**IG**	**HY**
Annualized Return	1.34%	0.86%	2.96%
Annualized Volatility	6.10%	5.12%	7.80%
Shape ratio	0.22	0.17	0.38
With the ESG factor	**All**	**IG**	**HY**
Annualized Return	1.07%	0.61%	3.74%
Annualized Volatility	4.43%	3.57%	7.61%
Shape ratio	0.24	0.17	0.49

6. Conclusion

This report examined the impact of the Size and ESG factors in quantitative strategies across the sovereign bond market in the past 13 years. In this context, Size was defined as the total public/government debt of each country, while a novel ESG factor was constructed to provide innovative insights on its integration at country level. Our sample is composed of nearly 115,000 bond-month observations from emerging and developed countries.

The results show that, in general, the equally-weighted portfolios ranked by Size performed better than their benchmarks. Particularly, the Long-Short strategies benefited strongly from a reduction in volatility. In an attempt to better replicate an implementable strategy, Long-Only

portfolios were constructed and ended up delivering higher risk-adjusted returns than the more theoretical Long-Short portfolios. Moreover, the separation in credit rating groups allowed for the positive effect from the Size factor to be enhanced in the worst-rated Long-Only portfolios, as premiums were attainable when controlling for higher relative credit risk. Although there seemed to be no clear distinctions between the performance of emerging and developed markets, it was evident that the former were more volatile, as was expected due to their intrinsic characteristics.

The introduction of the ESG factor did not translate into a clear improvement of performances. The potential benefits of the ranking by ESG scores may have been offset by restricting the universe of countries to invest in. Nevertheless, not only the ESG factor generally did not compromise the Sharpe ratios, but it also did not change the fact that all strategies yielded a higher number of months with positive returns than negative, with steady percentages of around 55% to 60% of positive months. As usual, diversification is key, and as the group report proved, the inclusion of the Size and ESG factors in multi-factor portfolios yielded better risk-adjusted returns than our single-factor strategies.

Although the short period of the analysis may give rise to some time period bias, it is important to point out that ESG measures are relatively recent, with reliable and relatively consistent data being available only for the past decade. Finally, we believe that this research and its innovativeness – mainly regarding the integration of a novel ESG factor in sovereign bond markets – is yet another original contribution to the quickly expanding literature on ESG standards and approaches to quantitative strategies, which we believe to be one of the main recurring topics in this new decade.

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Appendix

Appendix Exhibit 1: Universe Composition

Emerging Markets (EM)

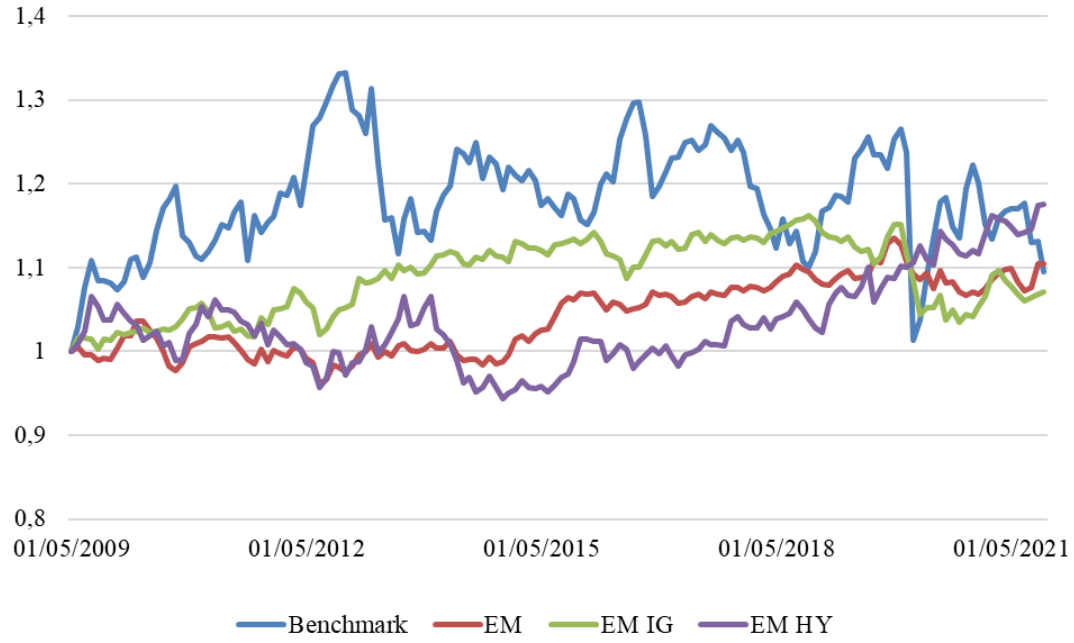
Year	Number of Bonds	% IG	% HY	% DS
2009	431	49.2%	39.1%	11.7%
2010	779	49.7%	32.0%	18.3%
2011	968	54.2%	36.9%	8.9%
2012	1082	52.5%	36.2%	11.3%
2013	1222	50.9%	30.8%	18.3%
2014	1426	51.4%	27.7%	20.9%
2015	1508	52.0%	26.9%	21.2%
2016	1591	51.8%	26.7%	21.4%
2017	1709	51.8%	26.4%	21.8%
2018	1945	51.8%	23.7%	24.5%
2019	2036	51.3%	26.6%	22.1%
2020	2002	48.6%	28.5%	22.9%
2021	2041	40.2%	23.0%	36.8%
Average	1424	50.4%	29.6%	20.0%
Number of issuers: 41 countries				

Developed Markets (DM)

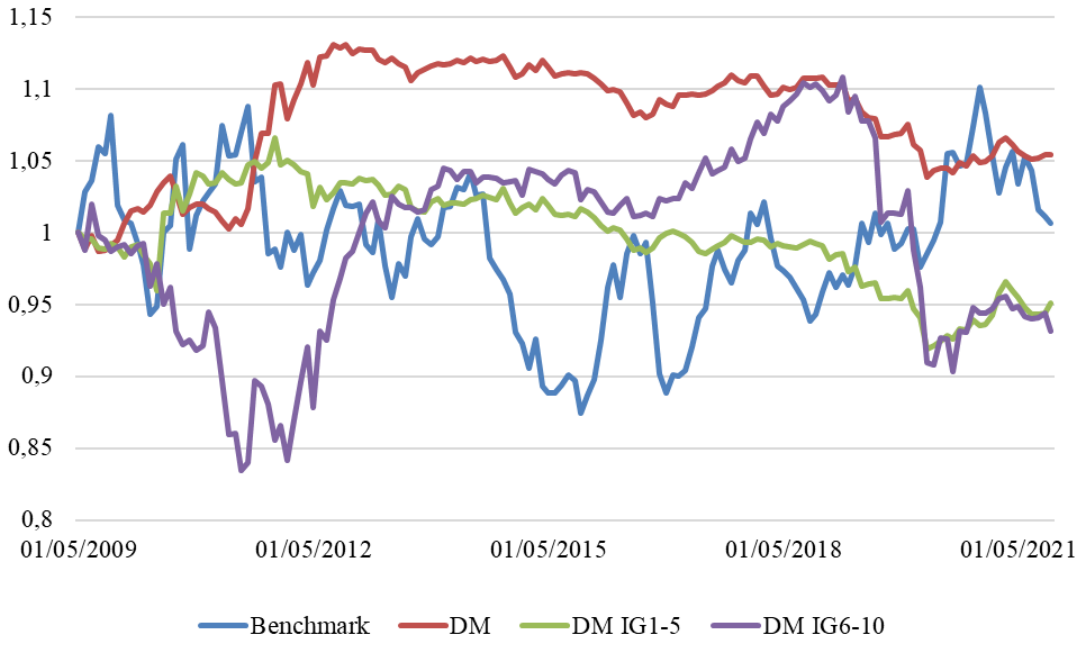
Year	Number of Bonds	% IG	% HY	% DS
2009	1633	100.0%	0.0%	0.0%
2010	3183	100.0%	0.0%	0.0%
2011	3641	98.9%	1.1%	0.0%
2012	4098	98.5%	1.5%	0.0%
2013	4512	97.2%	2.8%	0.0%
2014	4889	98.7%	1.3%	0.0%
2015	5140	98.7%	1.3%	0.0%
2016	5294	98.7%	1.3%	0.0%
2017	5540	99.0%	1.0%	0.0%
2018	5754	99.7%	0.3%	0.0%
2019	5942	98.7%	1.3%	0.0%
2020	6237	98.7%	1.3%	0.0%
2021	5427	98.7%	1.3%	0.0%
Average	4715	98.9%	1.1%	0.0%
Number of issuers: 22 countries				

Note: IG stands for Investment Grade, HY for High Yield, and DS for Distressed bonds. Investment grade bonds have a credit default risk between 0% and 0.52%, High Yield bonds between 0.52% and 10%, and Distressed bonds between 10% and 100%.

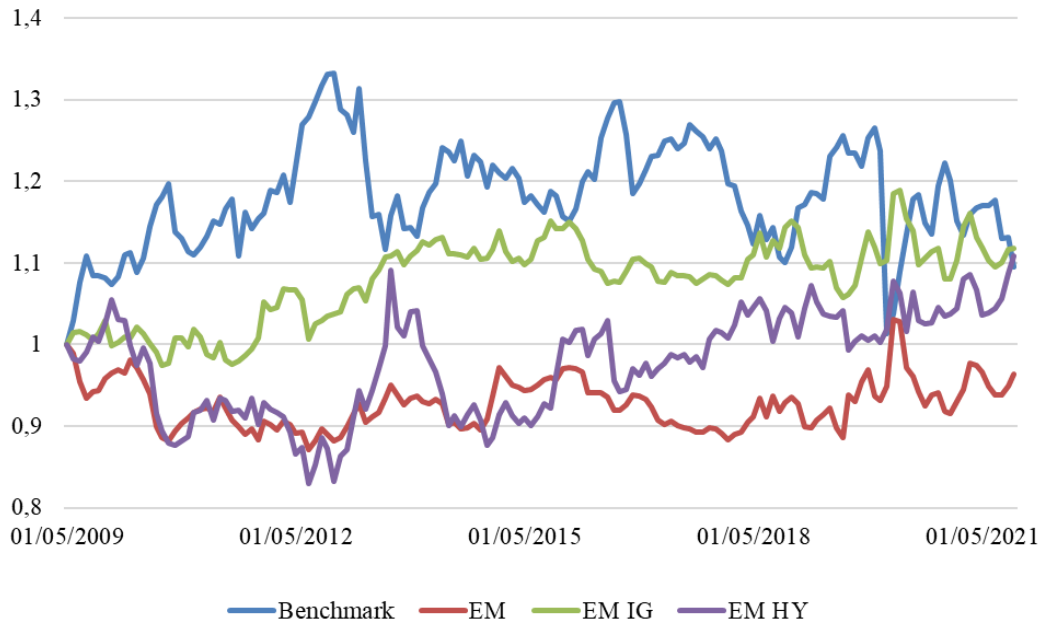
Appendix Exhibit 2: Cumulative returns of Long-Short strategies from Emerging Markets



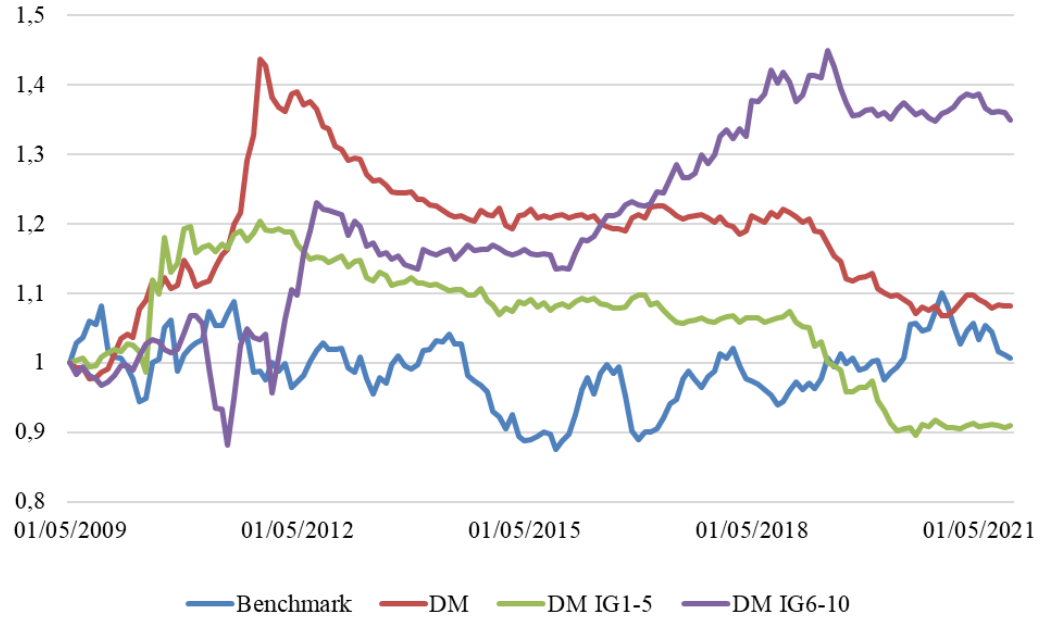
Appendix Exhibit 3: Cumulative returns of Long-Short strategies from Developed Markets



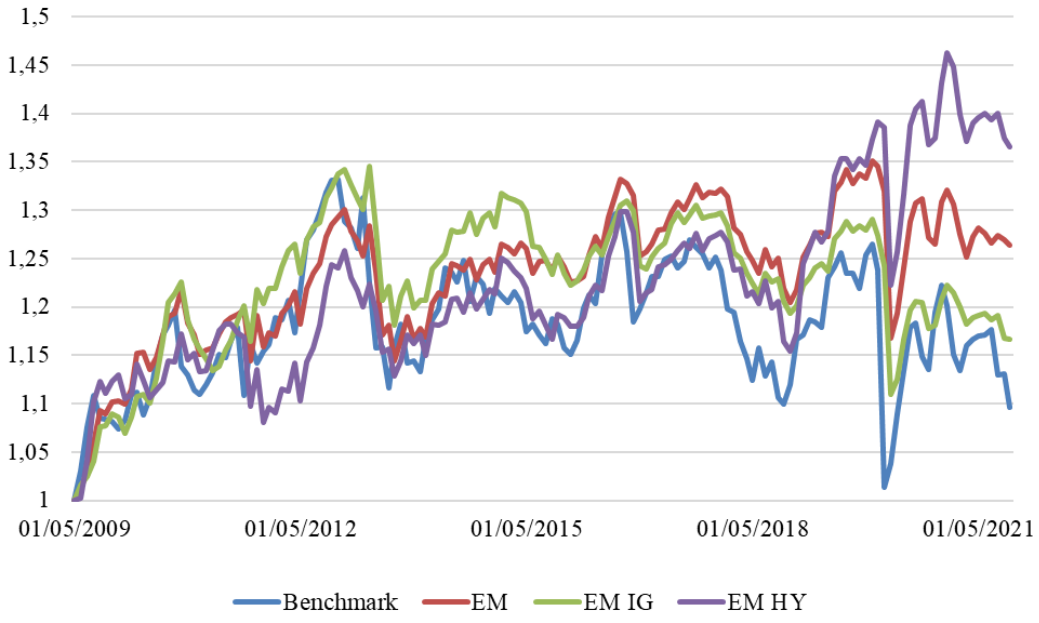
Appendix Exhibit 4: Cumulative returns of Long-Short strategies from Emerging Markets with ESG integration



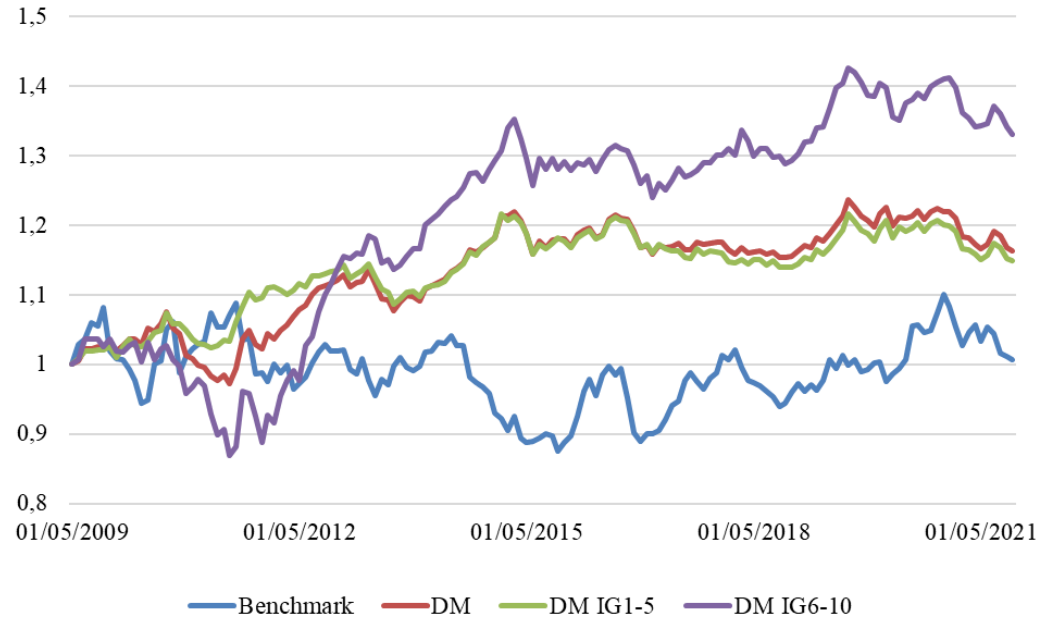
Appendix Exhibit 5: Cumulative returns of Long-Short strategies from Developed Markets with ESG integration



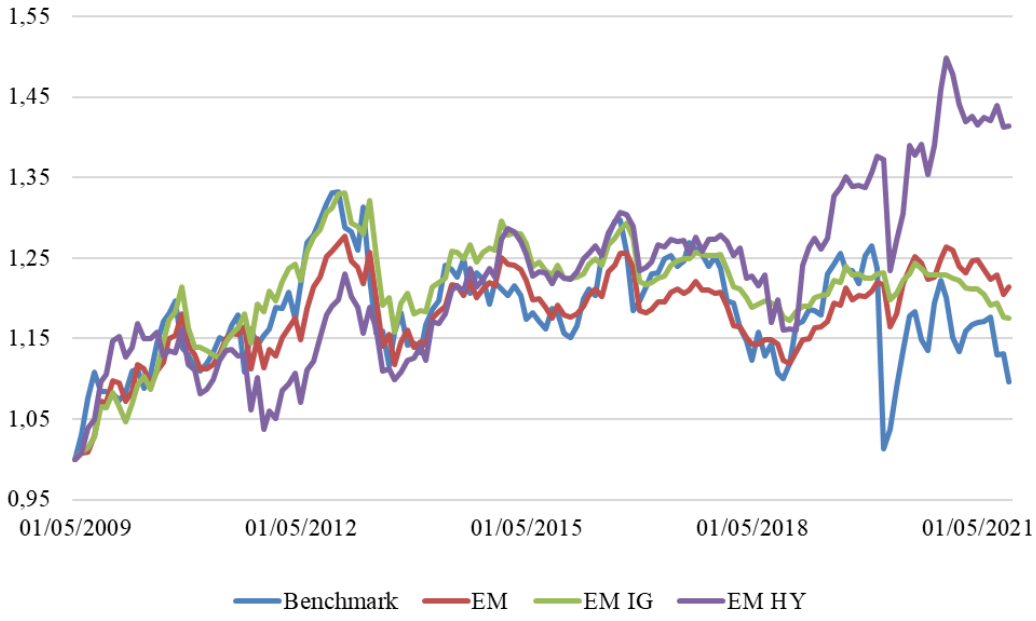
Appendix Exhibit 6: Cumulative returns of Long-Only strategies from Emerging Markets



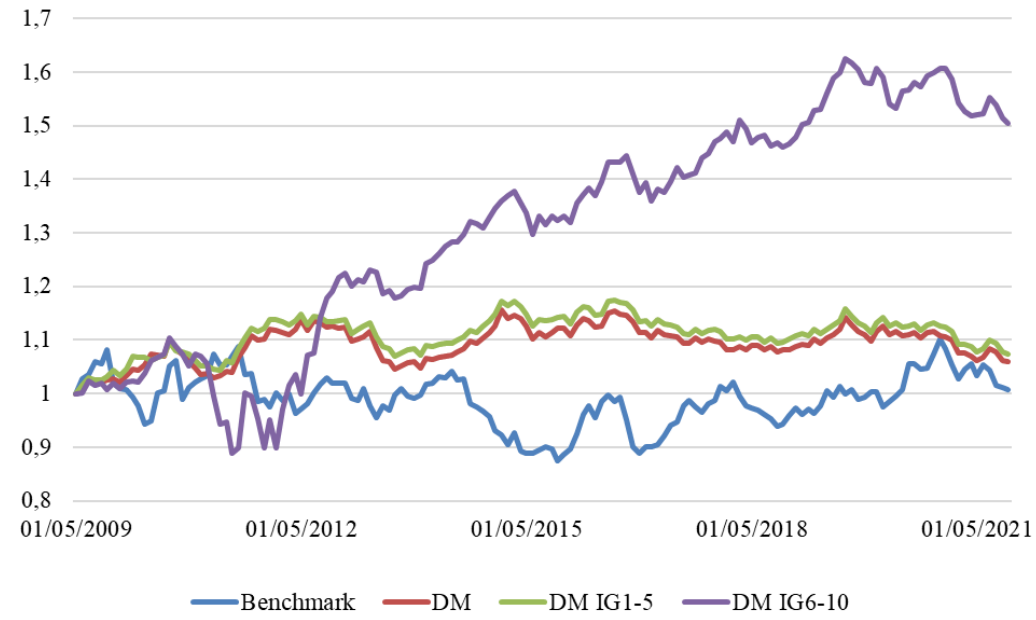
Appendix Exhibit 7: Cumulative returns of Long-Only strategies from Developed Markets



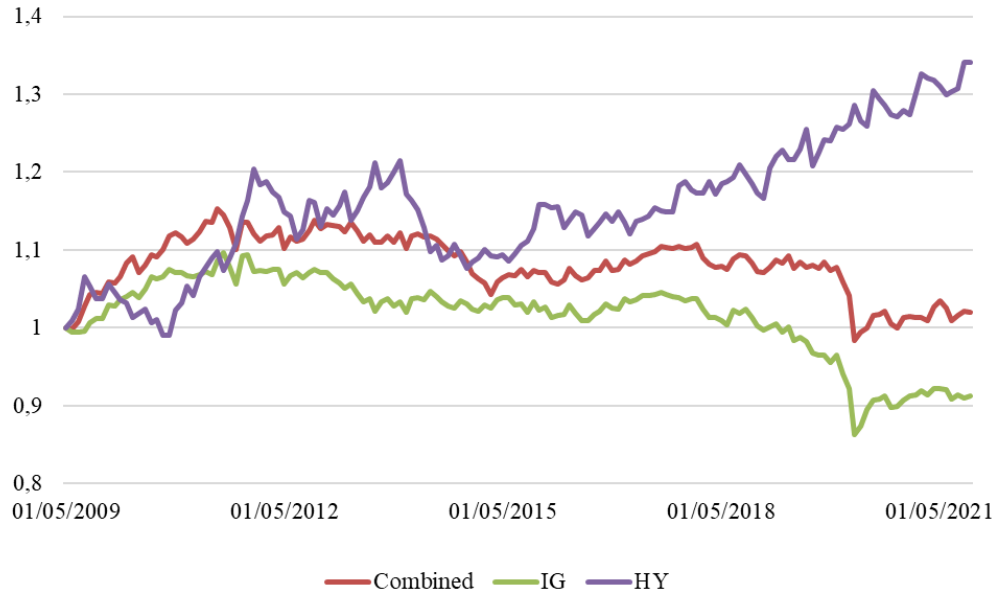
Appendix Exhibit 8: Cumulative returns of Long-Only strategies from Emerging Markets with ESG integration



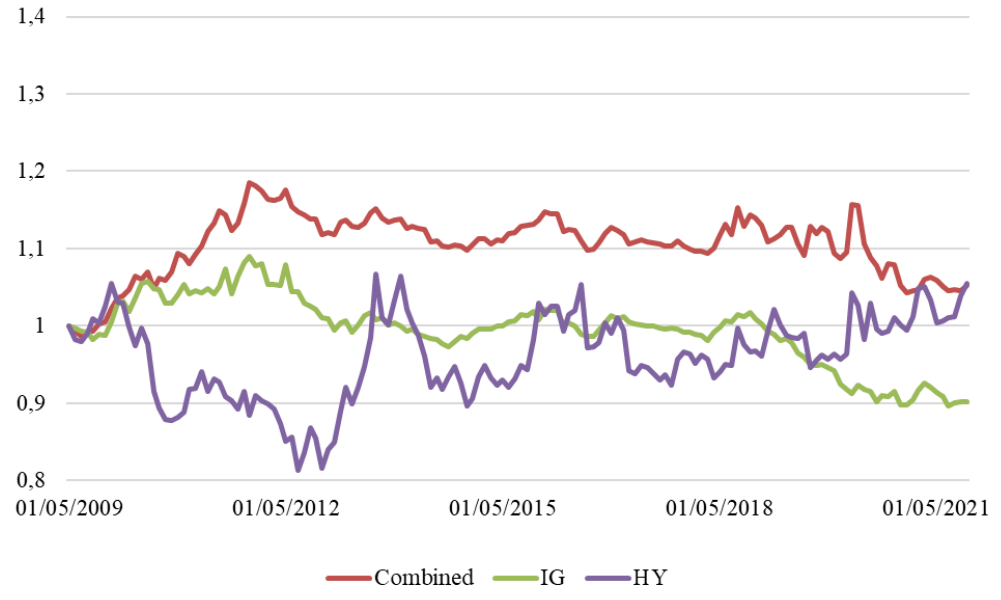
Appendix Exhibit 9: Cumulative returns of Long-Only strategies from Developed Markets with ESG integration



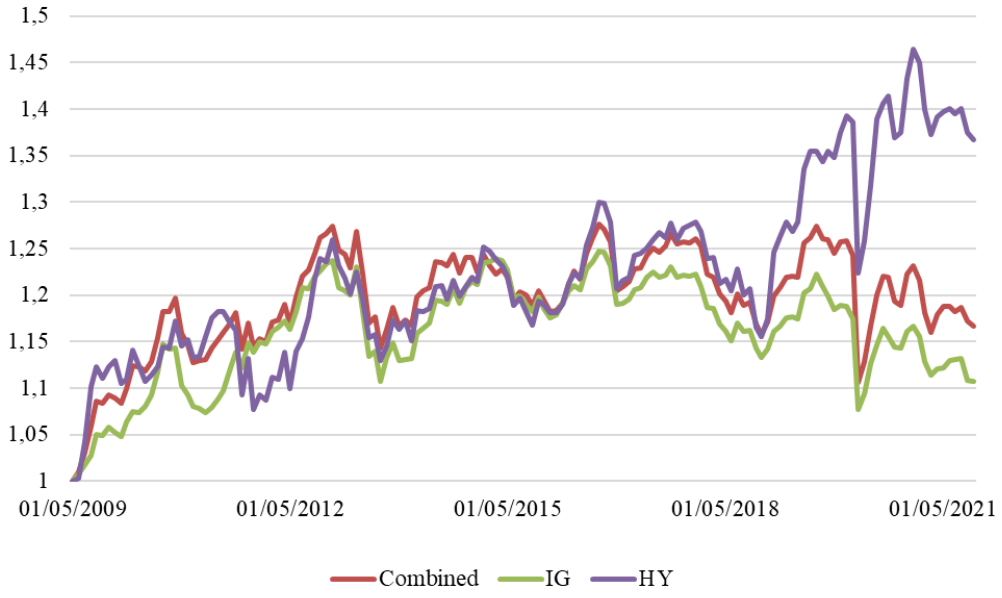
Appendix Exhibit 10: Cumulative returns of Long-Short combined markets strategies



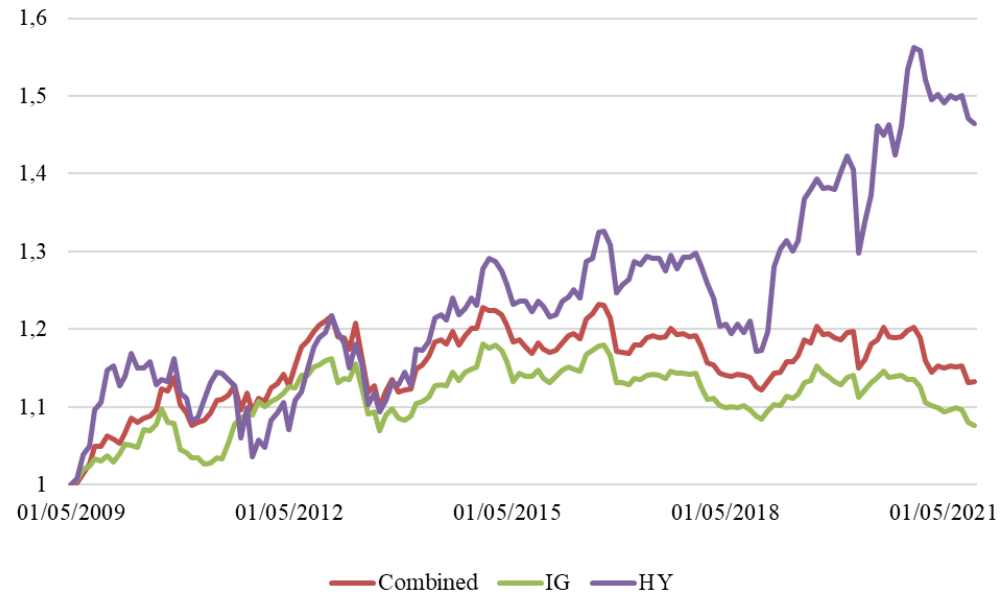
Appendix Exhibit 11: Cumulative returns of Long-Short combined markets strategies with ESG integration



Appendix Exhibit 12: Cumulative returns of Long-Only combined markets strategies



Appendix Exhibit 13: Cumulative returns of Long-Only combined markets strategies with ESG integration



A Work Project, presented as part of the requirements for the award of a Master's degree in Finance from the Nova School of Business and Economics.

Integrating ESG in Factor-Based Investing: An Approach to Sovereign Bonds in Emerging and Developed Markets

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17-12-2021

Abstract

This report analyses the collective impact of Momentum, Value, Size, and Low Volatility in factor-based investing in sovereign bond emerging and developed markets. Additionally, an ESG factor was developed and its effects across all strategies were assessed. Results show that the multi-factor portfolios generally tend to exhibit higher risk-adjusted returns than the benchmarks, while the ESG integration improves their performances. Controlling for some degree of credit default risk also proves to enhance the benefits of including the factors. The results are robust with out-of-sample research on the impact of ESG performance in corporate bonds.

Keywords**:** Finance, Financial Markets, Data Analysis, Sovereign Bond Markets, Emerging Markets, Developed Markets, Factor-Based Investing, ESG, Momentum, Size, Value, Low Volatility

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1. Introduction

Fixed income investing plays a crucial role in any portfolio, as bond returns are often less risky than equities and help to diversify investments.

When investing in bonds, one must consider the bond's maturity and rating, as well as the macroeconomic risks. Bond investing is subject to various types of risk, such as interest rate risk, inflation risk, credit risk, and liquidity risk. Interest rates are a function of money supply and demand, inflation rate, business cycle, and monetary and fiscal policies, impacting bonds price negatively. Inflation risk is reflected in the actual bond return, as when inflation rises, the fixed coupons will reflect a lower purchasing power than at the settlement date. Credit risk reflects the probability that bond issuers could not meet coupon or principal payments. Finally, liquidity risk accounts for the possibility of wanting to sell a bond but being unable to find a buyer.

Bonds' main advantages are income generation, risk management, diversification, and capital preservation. First, bonds provide a fixed income at coupon dates (income generation). Bonds typically reflect a lower risk than stocks and have an inversive relationship, i.e., when the bond market is up, stocks become less appealing. For these two reasons, bonds are used in portfolios for diversification and risk management purposes. Also, paying a principal protects the absolute investment value, which is beneficial for investors with less time to recoup losses.

Emerging Markets are characterised by a transition from a low income, pre-industrial economy towards a more global one, leading to rapid economic growth. For this reason, the risk profile differs from that of Developed Markets, providing a greater return and a greater exposure to risk. Emerging Markets give investors an opportunity for high returns and to diversify their exposure to Developed Markets, which has been growing. According to Dekker, Houweling

and Muskens (2021), the Emerging credit market has grown from $50 billion to $1.8 trillion from 2001 to 2018.

ESG stands for Environmental, Social, and Governance, and it is a set of standards that socially conscious investors usually use to evaluate companies and screen potential investments. Currently, these criteria are far from being consensual, and their inherent subjectivity is a challenge to standardisation. Besides, one might think that using non-financial factors to build investing strategies can threaten alpha maximisation. Even though this sometimes may be the case when those factors restrict the universe of investments, there are reasons to believe that incorporating ESG concerns in investment decisions can ultimately benefit alpha and risk-adjusted returns. The argument is that an enterprise that worries about the environment, is socially responsible, and promotes good governance practices, has better growth opportunities and poses less financial risk in the future than a company that otherwise does not care for ESG standards. See, for example, the cases of Volkswagen's carbon emissions scandal of 2015 (Environmental), BBC's gender pay gap controversy of 2017 (Social), and Enron's accounting fraud scandal of 2001 (Governance). As a result, all these companies' reputation was severely hit, and their financial health was compromised – Enron even had to file for bankruptcy.

Moreover, it is essential to discuss further why ESG can also be a helpful predictor of public debt's risk and return. Investors have shown a growing demand for more disclosure of sustainability risks (Hübel and Scholz, 2020): in 2020, there was a lawsuit against the Australian government, as it failed to disclose material risks of climate change of its sovereign bonds (Smyth, 2020). In 2019, during the period of riots in Hong Kong, major protests were happening, and people's freedom was being threatened (Social). This led to one notch decrease in foreign-currency-issuer default risk with Fitch, as the first credit agency to make this move. This reflects the impact that ESG has on the credit risk of sovereign entities, thus the relevance of accounting for ESG to predict bonds' return better.

Overall, the paper aims to understand what the impact of the inclusion of a sustainability component to investments might be in comparison with more conventional approaches, particularly in fixed income markets, and whether the inclusion of ESG means to sacrifice financial return or, on the other hand, delivers better risk-return metrics. We also aim to analyse the differences in results between Emerging and Developed markets, see which ESG is more priced in, if at all, and provide new insight into the drivers of bond returns.

2. Literature Review

Factor investing is an investment approach that targets specific drivers of returns across asset classes, giving exposure to systematic sources of risk. For that reason, there can be thousands of essential characteristics explaining sources of risk and return, making the term "factor" be generously used. For instance, some factors can be statistically significant in explaining returns but do not generate a premium over long periods, and so those may not be considered good drivers for longer-term factor investing (Bender, et al. 2013).

Since they are not as easy to observe as returns, there are some challenges in defining and estimating factors. Some techniques include constructing a factor portfolio that mirrors the target factor, as in the Fama-French approach, or they can be estimated through cross-sectional regressions, as in the Barra approach (Bender, et al. 2013). There are different types of factors, mainly macroeconomic factors such as Economic Growth, Inflation, Liquidity, or style factors such as Value, Volatility, Momentum, Size, which are the main focus of this paper. Practitioners have studied the latter for an extended period as part of the academic asset pricing literature and proved successful among different asset classes.

Over the years, investors have been looking for ways to make their investments more impactful on top of their financial objectives, and according to the Global Sustainable Investment Alliance

(GSIA 2020), at the start of 2020, global sustainable investment totalled $35.5 trillion, representing a 15% growth from the previous two years (2018-2019). One way to increase that impact is by gaining exposure to sustainability factors such as ESG, as it incorporates Environmental, Social, and Governance criteria into the analysis and selection of investments. Different approaches can be used to gain exposure to ESG, mainly: 1) purchase of 'labelled' green bonds or investing in ESG/SRI (Socially Responsible Investment funds); 2) follow ESG indices; 3) hire ESG active managers; 4) incorporate and embed ESG across the whole investment process, as part of the credit risk analysis (Inderst and Stewart 2018). Alternatively, investors can pursue a restriction list-based approach (SRI) by not investing in companies involved in controversial areas.

When considering sovereign credit markets, one can consider a relationship between ESG metrics and sovereign spreads. Capelle-Blancard et al. (2017) analysed whether macroeconomic and ESG factors determined sovereign bond risk. Currently, two arguments support this relationship. The first is that investors are changing their preferences and thus seeking returns and diversification and considering the impact of their portfolios. The other is that qualitative sustainability criteria can improve financial performance and risk management by considering other factors in the decision-making process. This is particularly relevant in sovereign bonds, as they are influenced by interest rate risk (macroeconomic conditions) and liquidity/solvency risk, measured mainly by credit ratings and yields. The inclusion of ESG in this paper aims at precisely understanding this dynamic of risk. Assuming that countries with higher ESG scores will tend to have lower spreads, portfolios can hedge that risk when considering lending money and planning strategic asset allocations across geographies (Capelle-Blancard, et al. 2017).

Capelle-Blancard, et al. (2017) highlights three key findings. Firstly, the correlation between ESG indicators and government bond spreads is more robust in the long term than in the short

term. Secondly, the financial impact of governance performance is more significant than social and environmental. Thirdly, the relationship between ESG performance and sovereign spreads is more robust in the eurozone than in other developed countries and more evident after the financial crisis in 2008. This result is not surprising considering that upon the 2008 subprime crisis that led to the European Sovereign Debt crisis, policymakers and investors had to find new mechanisms to assess credit risk, other than traditional financial metrics.

However, assessing credit risk solely based on ESG performance may lead to poorly diversified portfolios because developed markets tend to have relatively higher ESG scores than emerging markets. This can lead to further investing and financing asymmetries in these poorly ESG rated countries. If ESG concerns are the primary screening criteria, these developing countries may not get the necessary funding to finance their budgetary programs and function adequately. In turn, that can cause a snowball effect, as financing problems usually translate into a crisis (smaller or bigger), which aggravates investors' concerns and can create a systemic impact on markets.

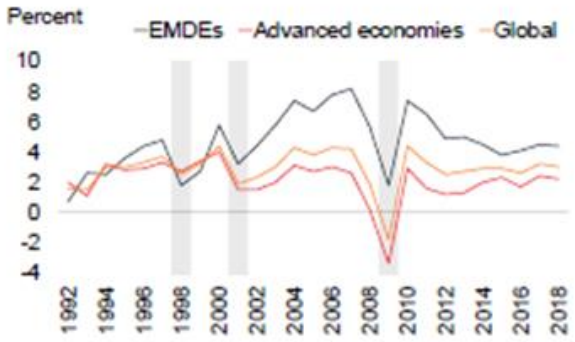
One of the main challenges of integrating ESG standards – which are qualitative by nature – in quantitative investment strategies is precisely determining each topic's relative importance (also known as the "materiality"). Additionally, optimally integrating financial and non-financial goals without sacrificing alpha is relatively fresh in the current scientific literature landscape.

3. Macroeconomic overview

When dealing with a dataset composed exclusively of sovereign bonds issued by countries either classified as emerging or developed countries, a macroeconomic context is crucial to better assess and interpret the strategy's results, especially considering the events that occurred in the last 13 years.

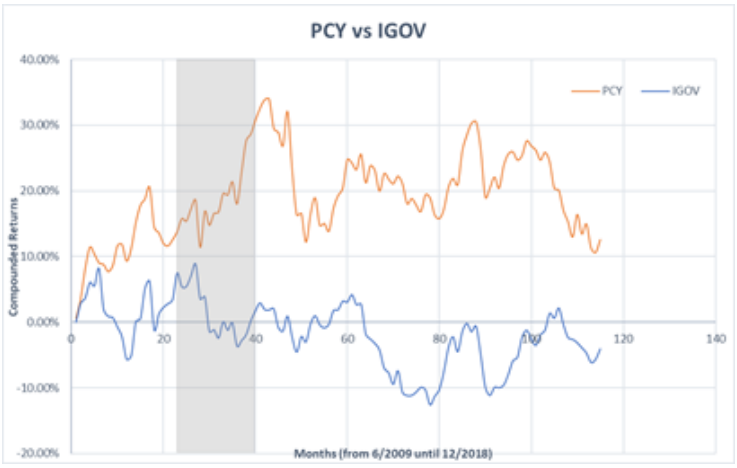
This timeframe holds the period right after 2009's global economic recession until 2021, which affects our sub-universes differently. In developed/advanced economies, the banking crisis in 2008 in the United States led to a sovereign debt crisis that peaked in 2011 and 2012 in the euro area (where most developed countries that comprise our DM sub-universe are). Due to the financial dependence between world economies, the recession ultimately spread to countries belonging to emerging markets. Surprisingly, emerging economies that were not too exposed to eurozone debt rebounded from the economic recession relatively well, at least compared to developed ones (Kose and Ohnsorge, 2020). Exhibit 1 compares the growth between the two (note that EMDEs stands for Emerging Markets and Developing Economies, a classification that includes all the countries in our EM sub-universe).

Exhibit 1 - Growth around global recessions



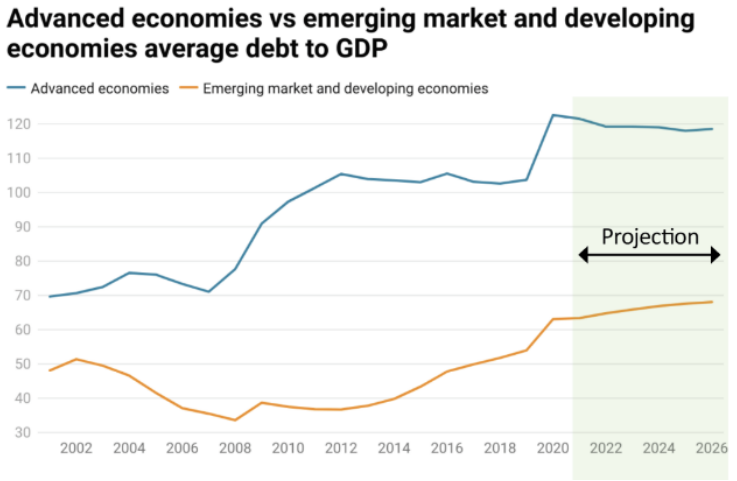
This difference in growth can also be observed by comparing the compounded returns of the two benchmarks (PCY and IGOV) in the timeframe between 2009 and 2018, which shows that during that period, emerging economies' sovereign bonds thrived, while the developed economies were struggling (Exhibit 2 - the peak of the sovereign debt crisis of the euro area is highlighted in grey). This growth gap was exacerbated by a looser monetary policy and fiscal stimulus in many EM countries in relation to DM countries. Kose and Ohnsorge (2020) mention that "G20 countries introduced fiscal packages equivalent to 1.4% of global GDP. China had the largest stimulus package at 12.7% of GDP".

Exhibit 2 – Compounded returns of PCY and IGOV ETFs between 2009 and 2018



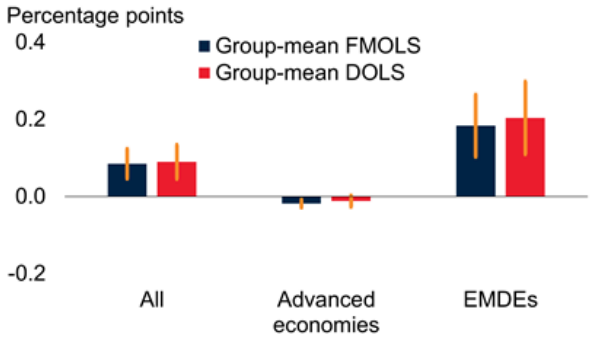
This fiscal and monetary policy has remained this way in most emerging economies throughout the same period. Most of them returned to fiscal balances close to 2007 levels, with interest rates climbing in only a few of them. Emerging economies became even more exposed to shocks by combining these factors with an increase in debt (Exhibit 3) and current account deficits.

Exhibit 3 – Debt-to-GDP ratio in advanced and developing economies



Although the Debt-to-GDP ratio of advanced economies is significantly higher than in emerging, their currencies and strong economies can withstand increases in debt without threatening inflation, at least compared to EMDEs levels – see Exhibit 4, showing the impact of 10 percentage point increase in debt-to-GDP on inflation expectations.

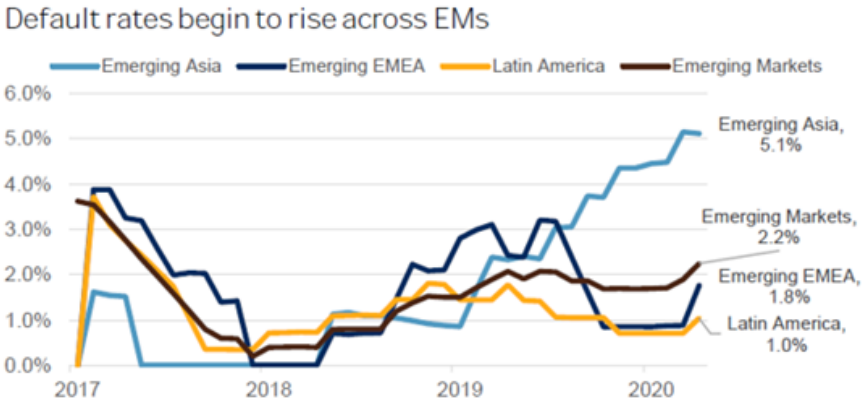
Exhibit 4 – Impact of 10 percentage point increase in the public debt-to-GDP ratio on the sensitivity of inflation expectations.



Notes: Bars denote coefficients of group mean panel fully modified OLS (FMOLS) and group mean dynamic OLS (DOLS) regressions of 24 advanced economies and 23 EMDEs using annual data for 1995-2016. Vertical lines denote 90% confidence intervals.

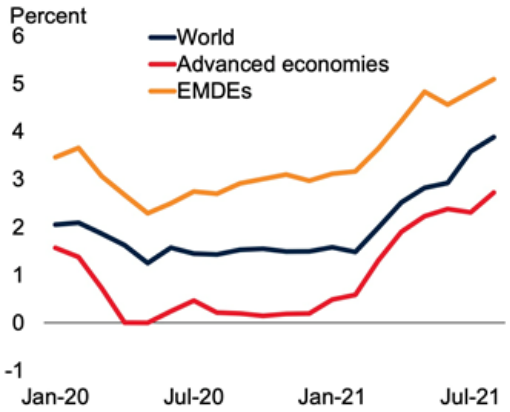
Finally, the COVID-19 pandemic that started at the end of 2019/beginning of 2020 represented the shock that burst most emerging economies that did not have the monetary policy tools to react to it, as they were already stretched. As a result, default risks (Exhibit 5) and inflation started to rise across emerging economies.

Exhibit 5 – Default rates in Emerging Markets



Although inflation (Exhibit 6) can be credited for debt reduction in some advanced economies, generally combined with financial repression (Kose, et al. 2021), in EMDEs, this usually is not the case, as a large part of short-term debt is denominated in foreign currency (normally, strong currencies). In this case, inflation can worsen the problem.

Exhibit 6 – Inflation in EMDEs and Advanced Economies



Note: CPI refers to a consumer price index. Year-on-year group median inflation for 81 countries, of which 31 are advanced economies and 50 are EMDEs.

4. Definition of the factors

Momentum

Momentum is a strategy of trend investing, which measures short-term past performance in the belief that the trend will sustain either to the upside or the downside. Most momentum strategies focus on the cross-section considering the relative performance of securities, buying those that outperform their peers and selling those that underperform. Alternatively, momentum can be approached using time-series by looking at the past performance of each security and buying those with past positive returns and selling those with negative past returns. In this paper, a third concept, "market time-series momentum", pioneered by Maesco, Martellini, and Rebonato (2019), is explored and applied to a broader context.

Bond returns tend to be correlated, and so this simple but effective strategy does not pick winners versus losers but instead captures the momentum of the broader market, based on market events and expectations, investing across the maturity and geography spectrum. Because momentum looks at the past returns, we considered a look-back period L that considers the 1-month past performance and a holding period of H months. To avoid data mining, L and H

are equal. At the end of month date t, the strategy considers all the N_t bonds that (i) are in the universe at time t, (ii) were in the universe at time t – 1, and (iii) that will be in the universe at time t + 1. The strategy is approached based on the performance of the market rather than on the securities individually. To do so, a market time-series with the market's returns at time t, $r_{m,t}$, was created as an equal-weighted portfolio of the bond's returns in the universe at time t. At a given date *t*, we consider the 1-month past performance of the market, $r_{m,L}$, such that if $r_{m,L} > 0$, the strategy goes long in all bonds in the universe that respect condition (i), (ii), and (iii) simultaneously, and hold the position H months. Otherwise, it takes a short position on those bonds.

Value

Value-based investing focuses on trading assets based on their intrinsic value. It compares the market value with intrinsic value and takes a position based on this differential. This is a long-term strategy based on the idea that markets overreact to news; hence price movements do not match the long-term company value.

Although value is extensively documented as a relevant factor that explains equity returns, very little literature supports a Value Factor on Fixed income, which is further analysed in the Value individual report.

For this paper, bonds' value will be assessed based on the respective Option Adjusted Spread (OAS). OAS reflects the difference in the bond yield with the embedded option and risk-free rate. It helps investors understand the intrinsic value by analysing the bond fixed cashflows and the embedded option separately, thus considering market volatility and reference rates. In addition, OAS allows for comparability between bonds with different redemption structures. On average, bonds with a more excellent intrinsic value provide higher returns than those with lower intrinsic value. For this reason, a Value portfolio will be created for each rebalancing

date. If a bond has an OAS higher than the median, a long position is taken and short otherwise. This approach provides positive returns when accounting for credit risk to ensure that the extra return is not coming from overweight in credit risk.

Size

The size factor, also known as the small-firm effect or the SMB factor (Small Minus Big) in Fama-French factor models, generally refers to an apparent anomaly in equity markets: stocks with smaller market capitalisations tend to deliver higher risk-adjusted returns than large-capitalisation stocks. However, this anomaly is less common in bond markets than in equity markets, as the literature on it is less in quantity and not as empirically conclusive as in stocks. Nevertheless, it can still be exciting to analyse whether the size factor can achieve higher risk-adjusted returns in credit markets, specifically in sovereign bonds, since most research is focused on corporate debt.

Using the equity market as a starting point, the size proxy is the total market capitalisation of a company, given by the market value of all its outstanding shares. Similarly, the size measure that will be used in this report is the total market value of a sovereign's outstanding debt, which is commonly known as Public Debt or Government Debt.

Ultimately, this means that we will analyse and test whether the sovereign debt returns of countries with smaller total public debts outperform the returns from higher ones. Notwithstanding, the economic meaning of that test must be discussed *a priori*: why can the size of a sovereign be a helpful predictor of its public debt's risk and returns? To answer this question, two reasons can be followed.

The first case is to acknowledge that the sovereigns exhibiting lower values of absolute total public debt within the overall sample have smaller public debt burdens. Here, the lower percentage of public debt to GDP translates into less credit default risk. Further, if the country

is also significant (in terms of GDP), its bonds are likely to be more liquid, making it even less risky. Moreover, a government not constrained by high debt obligations has broader means of taking advantage of economic growth and development opportunities.

The second case is the instance of small countries with high public debts. Within our sample, they can also be considered small in terms of the size factor because their absolute value of public debt is still comparatively lower. Bonds from smaller countries tend to be less liquid than from more significant countries, making room for investors to capture some illiquidity premium. Less liquidity in a market usually translates into more price discrepancies, which investors can exploit as arbitrage opportunities, for example. The individual report on size provides a deeper explanation of the size factor and its economic meaning.

Low-volatility

The low-volatility factor was first introduced by Haugen and Heins (1972) and challenged the premise that choosing securities with higher risk translates into higher rates of returns. A low-volatility factor portfolio seeks to capture better risk-adjusted returns by buying the lowest volatility bonds and/or selling the highest volatility bonds. One of the challenges of applying this to a sovereign bond investment universe is that the definition of volatility can take many forms, and the other sources of risks associated with these types of assets.

The existing literature diverges in a broad range of definitions for volatility in fixed income, such as the Libor Option Adjusted Spread (OAS) volatility, the Duration Times Spread (DTS), or the Modified Duration Times Yield (DTY). In this paper, volatility is defined as the standard deviation of the yield-to-maturity (YTM) for the trailing 4-month period, in a similar approach as described by Soe and Xie (2016). The choice of the smaller 4-month period, compared to the one chosen by Soe and Xie (2016), adapts to the short timeframe available. Moreover, especially in the emerging markets sub-universe, it is helpful to capture quick changes in the

YTM more efficiently, and a shorter period to compute the standard deviation of the YTM allows that.

It is crucial to keep in mind that in fixed income securities, where most systematic risk lies on interest rate and credit risk, it is crucial to keep these two constant while measuring volatility in terms of yield-to-maturity and constructing an investment strategy on it. Selecting securities with the lowest/highest YTM volatility without considering this may lead to concentrating interest rate risk or credit risk, which would tamper results.

Analysis of factors' correlation

It is crucial to analyse how the individual factor portfolios co-move to assess the possible benefits of a multi-factor strategy. Their correlations are presented in Exhibit 7.

Exhibit 7 – Correlations among factors in Emerging Markets sample

Without ESG	Momentum	Volatility	Value	Size
Momentum	1.00			
Volatility	0.10	1.00		
Value	0.11	0.68	1.00	
Size	0.10	0.80	0.91	1.00

With ESG	Momentum	Volatility	Value	Size
Momentum	1.00			
Volatility	0.63	1.00		
Value	0.67	0.83	1.00	
Size	0.68	0.82	0.93	1.00

Considering the entire portfolio of Emerging Markets, Momentum is significantly less correlated with the remaining three factors, as this strategy focuses on market trends, while the rest looks at bond specific characteristics. Despite factors' correlations being greater than 0.5 for all factors except momentum, they are still lower than 1, thus allowing for partial diversification benefits in a multi-factor portfolio.

With the introduction of ESG, correlations increase as the number of available bonds within each strategy decrease substantially. As ESG is equally applied to all strategies, diversification decreases because factors will be integrated into the same post-ESG selected universe.

5. Data

The analysis is based on monthly data from emerging and developed sovereign bonds between May 2009 and October 2021 (150 months), totalling 1717 bonds from 74 different governments. The bonds of the emerging markets were extracted from the Invesco Emerging Markets Sovereign Debt ETF (ticker: PCY) and the developed markets' bonds from the iShares International Treasury Bond ETF (ticker: IGOV), both from Bloomberg. All bonds comprising ETFs were included in the universe, except for the bonds from South Korea belonging to the IGOV ETF because this country is already included in the PCY ETF. All bonds are fixed-rate and fully backed/guaranteed by their sovereign. Besides, all prices are quoted in USD.

The in-sample period of this strategy is relatively small, as ESG investing is a recent trend and the inception years of PCY and IGOV are 2007 and 2009, respectively. Moreover, the number of bond observations for Emerging Markets is relatively small compared to Developed Markets (42,000 vs 215,550), implying that it will be harder to find meaningful trends in the Emerging Market universe, on average. Of course, valid conclusions will still be drawn for the two universes, but it is essential to bear in mind the scope of each one.

Although government defaults are dissimilar to and less common than corporate defaults, our sample has no survivorship bias. Every month, bonds can enter or leave the dataset, and whenever a country defaults, their bonds' returns are based on the final trading price, reflecting the expected recovery rate.

Finally, monthly data is extracted from Bloomberg regarding sovereigns' credit ratings (Bloomberg Default Risk Scale). First, the dataset is divided into three categories: IG (Investment Grade), HY (High Yield), or DS (Distressed). Each of these categories is then subdivided: IG on a scale of 1 to 10, HY on a scale from 1 to 6, and DS on a scale from 1 to 5, with 1 being the worst. An example is the credit rating of Peru's debt in October 2021: IG9. More details on the credit rating of both datasets can be found below in Exhibit 8.

Exhibit 8 – Descriptive Data

A. Universe Composition

Emerging Markets (EM)				
Year	Number of Bonds	% IG	% HY	% DS
2009	454	49.2%	39.1%	11.7%
2010	935	49.7%	32.0%	18.3%
2011	1148	54.2%	36.9%	8.9%
2012	1278	52.5%	36.2%	11.3%
2013	1473	50.9%	30.8%	18.3%
2014	1729	51.4%	27.7%	20.9%
2015	1828	52.0%	26.9%	21.2%
2016	1942	51.8%	26.7%	21.4%
2017	2162	51.8%	26.4%	21.8%
2018	2472	51.8%	23.7%	24.5%
2019	2545	51.3%	26.6%	22.1%
2020	2551	48.6%	28.5%	22.9%
2021	2227	40.2%	23.0%	36.8%
Average	1750	50.4%	29.6%	20.0%
Number of issuers: 53 countries				

Developed Markets (DM)

Year	Number of Bonds	% IG	% HY	% DS
2009	1633	100.0%	0.0%	0.0%
2010	3183	100.0%	0.0%	0.0%
2011	3641	98.9%	1.1%	0.0%
2012	4098	98.5%	1.5%	0.0%
2013	4512	97.2%	2.8%	0.0%
2014	4889	98.7%	1.3%	0.0%
2015	5140	98.7%	1.3%	0.0%
2016	5294	98.7%	1.3%	0.0%
2017	5540	99.0%	1.0%	0.0%
2018	5754	99.7%	0.3%	0.0%
2019	5942	98.7%	1.3%	0.0%
2020	6237	98.7%	1.3%	0.0%
2021	5427	98.7%	1.3%	0.0%
Average	4715	98.9%	1.1%	0.0%

Number of issuers: 22 countries

Note: IG stands for Investment Grade, HY for High Yield, and DS for Distressed bonds. Investment grade bonds have a credit default risk between 0% and 0.52%, High Yield bonds between 0.52% and 10%, and Distressed bonds between 10% and 100%.

6. Development of the ESG factor

One of the critical points in this project was developing an ESG factor solely based on data. As mentioned before, there is an inherent subjectivity to what is considered material for all the three ESG components; as the dataset comprises only sovereign bonds, we wanted do develop a quantitative procedure that allowed rating each issuer (country) in the three individual components: Environmental, Social, and Governance. Annual data from 2008 to 2018 (the last year available) was collected from the World Bank public database, involving indicators that best characterise each country's performance in terms of Environmental, Social, and Governance aspects, according to the entity. An example of these indicators for the Governance

component for Brazil (one of the issuers in the Emerging Markets sub-universe) can be found in Exhibit 9.

Exhibit 9 - Description of Brazil's Governance indicators in the year 2008

Brazil's Governance indicators values	
	2008
Control of Corruption: Estimate	0.01
GDP growth (annual %)	5.09
Government Effectiveness: Estimate	-0.09
Individuals using the Internet (% of the population)	33.83
Political Stability and Absence of Violence/Terrorism: Estimate	-0.31
Proportion of seats held by women in national parliaments (%)	8.97
Ratio of female to male labour force participation rate (%) (modelled ILO estimate)	70.34
Regulatory Quality: Estimate	0.05
Rule of Law: Estimate	-0.32
Scientific and technical journal articles	35489
Strength of legal rights index (0=weak to 12=strong)	0
Voice and Accountability: Estimate	0.57

Financial data provider Refinitiv developed a quantitative methodology for evaluating corporations on ESG performance, on which we based our calculations and adapted to the universe of countries. The methodology starts by giving relative scores to each country (percentile scores) based on the value of the country's indicator relative to its peers – which can be the countries in emerging markets, developed markets, or in the combined datasets (note

that, due to the relative nature of these scores, the country's scores change depending on the dataset). For example, the percentile scores of Brazil for the Governance indicators shown above are displayed in Exhibit 10, relative to the countries within the Emerging Markets sub-universe.

Exhibit 10 - Description of Brazil's Governance percentile scores n the year 2008 among EM countries

Brazil's Governance percentile scores	
	2008
Control of Corruption: Estimate	0.66
GDP growth (annual %)	0.49
Government Effectiveness: Estimate	0.49
Individuals using the Internet (% of population)	0.64
Political Stability and Absence of Violence/Terrorism: Estimate	0.45
Proportion of seats held by women in national parliaments (%)	0.21
Ratio of female to male labour force participation rate (%) (modelled ILO estimate)	0.57
Regulatory Quality: Estimate	0.47
Rule of Law: Estimate	0.49
Scientific and technical journal articles	0.95
Strength of legal rights index (0=weak to 12=strong) (no values available until 2013)	0.00
Voice and Accountability: Estimate	0.76

To compute the final individual score for each country's Environment, Social and Governance components, we sum the values of each percentile score of the respective indicators (as shown above). As an example, Exhibit 11 compares the sum of the Governance percentile scores of Brazil and some of the emerging markets countries.

Exhibit 11 - Comparison of the sum of percentile scores between emerging markets countries

Sum of percentile scores of Governance indicators	
Country	**2008**
Angola	3.62
Brazil	6.19
Bulgaria	7.43
Chile	8.35
Colombia	4.66
Latvia	7.67

Finally, we collected data regarding each country's leading industries (in Brazil's case, the three leading industries are agriculture, iron and steel production, and oil processing), so we could assess the materiality of the individual components (Environmental, Social, and Governance) to the overall ESG factor. MSCI, one of the most recognised entities that rates companies on ESG parameters, has an ESG Industry Materiality platform, which quantifies the importance of ESG individual components (E, S, and G) within each industry. These values were used to create an industry materiality matrix by taking the average percentages given to E, S and G for all industries. It is relevant to highlight that this is the only step in calculating the factor that takes a qualitative approach, as the weight of each factor in each industry is subjective and varies among rating providers.

Exhibit 12 - Industries materiality matrix to compute the final ESG score

Industries Materiality Matrix			
Industry	**Environmental**	**Social**	**Governance**
Energy	42.9%	23.1%	34.0%
Consumer Staples	31.5%	34.8%	33.6%
Materials	45.3%	21.6%	33.1%
Consumer Discretionary	19.0%	43.4%	37.7%
Information Technology	16.2%	44.2%	39.5%
Industrials	22.8%	31.5%	45.7%
Utilities	47.5%	17.1%	35.3%
Financials	10.7%	52.4%	36.7%
Health Care	7.5%	53.9%	38.%
Communication Services	5.1%	50.5%	44.4%

Lastly, the ESG final score was computed as the product between the sum of the countries' percentile scores (for each individual parameter, Environmental Social and Governance) and the corresponding weights of the three leading industries in the industries' materiality matrix.

Exhibit 13 - Final ESG scores per year

Final ESG Scores						
Year	Angola	Brazil	Bulgaria	Chile	Colombia	Latvia
2008	4.70	5.52	5.75	6.17	4.64	6.29
2009	4.37	5.63	5.75	6.23	4.74	6.32
2010	4.12	5.70	5.48	6.25	4.82	6.30
2011	3.98	5.53	5.40	6.34	5.07	6.68
2012	4.50	5.45	5.49	6.43	4.90	6.56
2013	4.01	5.54	5.70	6.54	5.15	6.90
2014	4.35	5.33	5.68	6.47	5.49	6.78
2015	4.08	5.14	5.96	6.43	5.40	6.66
2016	3.97	5.27	6.02	6.73	5.23	6.62
2017	3.82	4.89	5.94	6.36	4.93	6.52
2018	4.02	4.89	6.09	6.47	4.99	6.88

Since there is no country-level ESG performance data in the World Bank database for 2019 and 2020 and considering that there were no significant changes in the final ESG scores throughout our sample in recent years, the scores from 2018 are attributed to those two remaining years. Furthermore, since each year's data was only known at the end of that year, each country's annual score is given to the following year to avoid a forward-looking bias. This way, we now have annual ESG data from 2009 to 2021, which we divide into monthly data by assuming the same score every month within a year.

7. Strategy and methodology

We analyse several multi-factor strategies to evaluate the impact of the ESG factor. The common aspect regarding the multi-factor portfolios is that they are composed of the four

individual strategies constructed independently by the authors in their projects. Recall that these incorporate one market anomaly and that both Long-Short and Long-Only approaches are taken. The complete signal construction can be further consulted in the authors' papers, but a quick preview is summed up below:

- **Momentum** Long-Only: go long (+1) on bonds whose past market return was positive;

  Momentum Long-Short: go long (+1) on bonds whose past market return was positive and short (-1) on the remaining.
- **Value** Long-Only: go long (+1) on bonds whose specific OAS (option-adjusted spread) is higher than the median OAS;

  Value Long-Short: go long (+1) on bonds whose specific OAS is higher than the median OAS and short (-1) on those whose specific OAS is lower than the median OAS.
- **Size** Long-Only: go long (+1) on bonds whose country's total public debt is lower than the median total public debt;

  Size Long-Short: go long (+1) on bonds whose country's total public debt is lower than the median total public debt and short (-1) on those whose country's total public debt is higher than the median.
- **Low Volatility** Long-Only: go long (+1) on the 25% of bonds with the lowest volatility that comprises each duration sub-group, equally weighting individual bonds inside each sub-group to keep interest rate risk constant.

  Low Volatility Long-Short: go long (+1) on the 25% of bonds with the lowest volatility and short (-1) on the 25% of bonds with the highest volatility that comprises each duration sub-group, equally weighting individual bonds inside each sub-group to keep interest rate risk constant.

The impact of the ESG factor is also incorporated individually for each factor. The bonds are ranked by their country's ESG scores and filtered into quintiles. This way, in Long-Short

strategies, we each go long (+1) on bonds ranked in the top 20%, short (-1) on those ranked in the bottom 20%, and discard (0) the remaining 60%. For the Long-Only, a long position (+1) is considered on the top 20% and disregard (0) the remaining 80%. Additionally, this is computed such that the final portfolio weights for each month are equal to 0 in Long-Short strategies and 1 in Long-Only strategies, except for Momentum due to its intrinsic characteristics.

Credit rating separations are also made at an individual level to assess any significant differences in terms of performance. For each market (emerging, developed, and both), we each divide our datasets of bonds into two categories: "best" and "worst". For emerging markets, the "best" bonds are those from countries whose credit rating is Investment-Grade (IG), and the "worst" are High-Yield (HY). For developed markets, since almost all bonds are Investment-Grade, the division is made differently: the "best" are those whose country's rating is between IG1 and IG5, and the "worst" are between IG6 and IG10. In this case, High-Yield bonds are not considered. Finally, the methodology from the emerging markets is applied for the combined sample. Note that Distressed bonds (DS) are not considered in any of the three markets for this credit rating analysis. The signal construction for this segment is the following: whenever a portfolio includes a credit rating division, the monthly signal is 1 for that category and 0 for the remaining, e.g., if we want to analyse the "worst-rated" countries in a Long-Short portfolio in emerging markets, the signal one is given to HY countries, while all remaining countries get the signal 0.

So, for each category (Long-Short or Long-Only + with ESG or without ESG + with credit ratings or without credit ratings), the multi-factor portfolio equally weights the individual strategies, creating a new weights matrix as follows:

$$W_{P_{i,t}} = \sum_{j=1}^{4} \frac{1}{4} \times W_{Pj_{i,t}}$$

$W_{P_{i,t}}$ is the weight of security *i* in the multi-factor portfolio, and $W_{Pj_{i,t}}$ is the weight of security *i* in each factor portfolio *j*. The weights' matrix is used to calculate the return of the multi-factor portfolio.

The choice of equally weighting the four individual portfolios, rather than constructing the multi-factor portfolio by integrating the four factors into a multi-factor score is made because the mixing approach is more transparent and allows for a more straightforward interpretation of results, as shown by Chow, Li, and Shim (2018) and Dekker, Houweling, and Muskens (2019). In addition, while the integration approach delivers better risk-adjusted returns, the more conservative mixing approach usually provides higher diversification and requires fewer implementation costs.

8. Empirical Results

This section presents the main results and conclusions from the strategies. Firstly, the benchmarks for the analysis are presented. Secondly, we analyse the more theoretical Long-Short portfolios and then look at the more practical Long-Only ones. Even though assessing the feasibility of implementing these portfolios is not the main scope of this report, it is essential to point out that many sovereign bonds cannot be shorted, and even if they can, it can be costly and more complex, especially in the emerging markets segment. Thus, Long-Short portfolios may not present realistic investment conclusions, as higher transaction costs can compromise returns. Nevertheless, the main goal here is to assess the combined impact of Momentum, Value, Size, and Low Volatility factors, as well as the ESG factor, in traditional strategies, and so we will focus more on the empirical results and less on the practical concerns

of implementing these strategies. Finally, we will also make comparisons with a mean-variance portfolio.

Benchmarks

The Invesco Emerging Markets Sovereign Debt ETF had an annual mean return of 1.22% and annual volatility of 9.69%, which resulted in a Sharpe ratio equal to 0.13. The returns distribution had a negative skewness of -2.01 and kurtosis of 11.29 (Leptokurtic distribution), meaning that most of the returns were positive with a high degree of risk related to the presence of extreme values. The maximum drawdown was -23.96%, and the cumulative return was 9.58%. On the other hand, the iShares International Treasury Bond ETF had an annual mean return of 0.09% and annual volatility of 7.36%, thus resulting in a Sharpe ratio of 0.01. The returns were with skewness of -0.53 and excess kurtosis of 0.75. The maximum drawdown was -19.61%, and the cumulative return was 1.16%.

Exhibit 14 – ETFs' Performance Statistics

Benchmarks		
	EM (PCY)	DM (IGOV)
Total return	9.58%	0.67%
Annualized return	0.77%	0.05%
Annualised volatility	9.69%	7.33%
Sharpe ratio	0.08	0.01
Positive months	55.70%	55.03%
Max. Drawdown	-23.04%	-12.32%
Skewness	-2.01	-0.45
Kurtosis	11.29	0.64

Therefore, in general, we can see that Emerging Markets sovereign bonds performed better than Developed Markets', which is not surprising given the time horizon of our analysis. Easing

monetary policies taken by central banks, a weakening of the US dollar, and higher yields made emerging markets attractive and investors willing to take on risks.

Long-Short strategy

Even though both emerging and developed markets' portfolios yield similar results in terms of the Sharpe ratio, the former is more volatile, which is expected due to its natural characteristics. However, in these portfolios, the relationship between risk and return is fairly linear (Exhibit 15), as the worst-performing portfolios have the lowest annualised returns, while the best-performing present the highest annualised returns.

Exhibit 15 - Multi-Factor Long-Short portfolio without ESG applied to Emerging and Developed Markets

Performance statistics

Emerging Markets			
Long-Short Portfolios	Long (All)	Long IG	Long HY
Annual Returns	-0.13%	1.01%	0.89%
Annual Standard Deviation	2.39%	2.11%	3.04%
Annual Shape Ratio	-0.06	0.48	0.29
Maximum drawdown	-3.64%	-3.70%	-6.62%

Developed Markets			
Long-Short Portfolios	Long (All)	Long IG1-5	Long IG6-10
Annual Returns	0.01%	0.54%	0.54%
Annual Standard Deviation	1.42%	1.30%	2.30%
Annual Shape Ratio	0.00	0.42	0.23
Maximum drawdown	-2.80%	-2.93%	-5.24%

The portfolios that comprise the entire sample present annualised returns and Sharpe ratios close to zero, while the ones that credit ratings' groups separate have annualised returns that range from 0.54% to 1.01%, and Sharpe ratios from 0.23 to 0.48 (higher than both emerging and developed markets' benchmarks). Moreover, constructing Long-Short portfolios grouped by credit rating yields significantly higher risk-adjusted returns than otherwise, especially in

the Investment-Grade (IG) and top Investment-Grade (IG1-5) segments. This can be attributed to the ability to control credit risk better and thus isolate the positive contribution of the four factors.

Exhibit 16 - Multi-Factor Long-Short portfolio applied to Emerging Markets

Exhibit 17 - Multi-Factor Long-Short portfolio applied to Developed Markets

Introducing the ESG factor has one collective impact across all portfolios, which is to almost double the volatility. So, naturally, their maximum drawdowns also present a sharp increase. The rationale is that by restricting the investment universe of bonds available to invest in, the ESG factor concentrates the same total weight on fewer bonds, making the overall volatility more reactive to comparatively smaller changes in each bond's standard deviation. As usually, less diversification corresponds to more risk.

Exhibit 18 - Multi-Factor Long-Short portfolio applied to Emerging and Developed Markets with ESG integration

Performance statistics

Emerging Markets			
Long-Short Portfolios with ESG integration	Long (All)	Long IG	Long HY
Annual Returns	0.86%	2.68%	1.01%
Annual Standard Deviation	5.57%	4.99%	5.20%
Annual Shape Ratio	0.15	0.54	0.19
Maximum drawdown	-12.21%	-12.59%	-12.23%

Developed Markets			
Long-Short Portfolios with ESG integration	Long (All)	Long IG1-5	Long IG6-10
Annual Returns	0.86%	0.08%	0.18%
Annual Standard Deviation	3.62%	2.14%	3.68%
Annual Shape Ratio	0.24	0.04	0.05
Maximum drawdown	-7.02%	-5.65%	-7.00%

Nevertheless, the integration of the ESG has a significant impact on the emerging and developed markets' portfolios that comprise the entire sample, as their Sharpe ratios go from negative and zero to 0.15 and 0.24, respectively. Curiously, they both present the same annualised return (0.86%), but not surprisingly, the emerging markets portfolio is more volatile. Moreover, and even though it does not happen in emerging markets, the ESG inclusion worsens the performance of both portfolios separated by credit rating categories from the developed markets, mainly through the returns. This makes us conclude that, throughout this period, the

ESG factor applied to specific credit risk groups is counter-effective, particularly in European countries, especially after the peak of the European Sovereign Debt Crisis (Exhibit 20).

Exhibit 19 - Multi-Factor Long-Short portfolio applied to Emerging Markets with ESG Integration

Exhibit 20 - Multi-Factor Long-Short portfolio applied to Developed Markets with ESG Integration

Long-Only Strategy

Analysing the results of the more practical Long-Only portfolios, the annual returns of the multi-factor portfolio applied for both Developed and Emerging Markets sub-universes performed identically with 0.83% and 0.91%, respectively, and both with a cumulative return of approximately 10%. The main differences lie in risk, as the multi-factor portfolio for Emerging Markets annual volatility is almost double that of the Developed market, at 6.63%, thus leading to a lower Sharpe ratio of 0.14 versus the 0.26 of the developed market markets (see Table 6). This difference can be attributed to the intrinsic risk nature of both markets, which translates into a more volatile distribution of the cumulative returns for the Emerging markets compared to the Developed markets. These show a more evident trend to the upside over time, hence the difference in the maximum drawdown between the two.

Exhibit 21 - Multi-Factor Long-Only portfolio without ESG integration applied to Emerging and Developed Markets

Performance statistics

Emerging Markets			
Long-Only Portfolios	Long (All)	Long IG	Long HY
Annual Returns	0.91%	1.04%	1.74%
Annual Standard Deviation	6.63%	5.88%	6.49%
Annual Shape Ratio	0.14	0.18	0.27
Maximum drawdown	-16.58%	-13.29%	-14.27%

Developed Markets			
Long-Only Portfolios	Long (All)	Long IG1-5	Long IG5-10
Annual Returns	0.83%	1.24%	1.73%
Annual Standard Deviation	3.16%	3.12%	4.98%
Annual Shape Ratio	0.26	0.40	0.35
Maximum drawdown	-5.42%	-5.40%	-10.08%

As described in the macroeconomic overview, the European Sovereign Debt Crisis that peaked in 2011 led to a disbelief in some sovereign countries' ability to fulfil their responsibilities with their counterparties (e.g., the debt restructuring of Greece in 2012) which can be observed in the difference in the performance of Emerging and Developed markets during that period. Additionally, the strategy outperformed the benchmark during the same period except for the High-Yield universe due to a risk aversion sentiment over that period, thus favouring the Investment-Grade universe. Besides, a similar correlation can be found in 2020 upon the Covid shock, as investors moved from riskier assets such as emerging markets bonds into more safe assets such as sovereign bonds of developed countries. Therefore, the strategy applied to emerging markets had a massive pullback (greater than the market), while developed markets increased significantly over that period. As the Long-only strategy cannot short bonds, it cannot benefit from down markets, whereas the Long-Short strategy could perform significantly better.

Exhibit 22 - Multi-Factor Long-Only portfolio applied to Emerging Markets

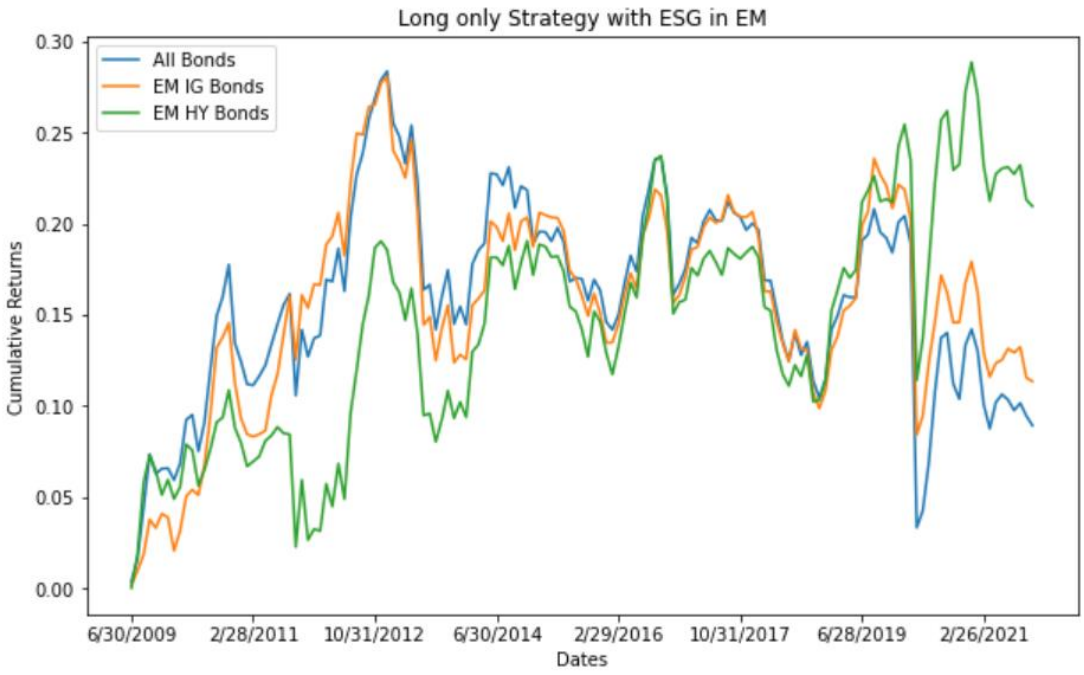


Exhibit 23- Multi-Factor Long-Only portfolio applied to Developed Markets with ESG Integration

The inclusion of the ESG factor allowed for an increase in returns in both markets. In terms of volatilities, the results remained identical, which allowed for an increase in Sharpe ratios to 0.29 in Emerging Markets and 0.34 in Developed Markets. Moreover, there was a pronounced improvement on Emerging Markets return's distribution, which translated into a reduction of the maximum drawdown to -8.30%. Hence, the ESG factor worked as a hedge that improved the results significantly risk-return characteristics.

Exhibit 24 - Multi-Factor Long-Only portfolio with ESG integration applied to Emerging and Developed Markets

Emerging Markets

Long-Only Portfolios: With ESG Integration	Long (All)	Long IG	Long HY
Annual Mean	1.53%	1.53%	1.59%
Annual Standard Deviation	5.34%	5.12%	5.96%
Annual Shape Ratio	0.29	0.30	0.27
Maximum drawdown	-8.30%	-9.13%	-11.52%

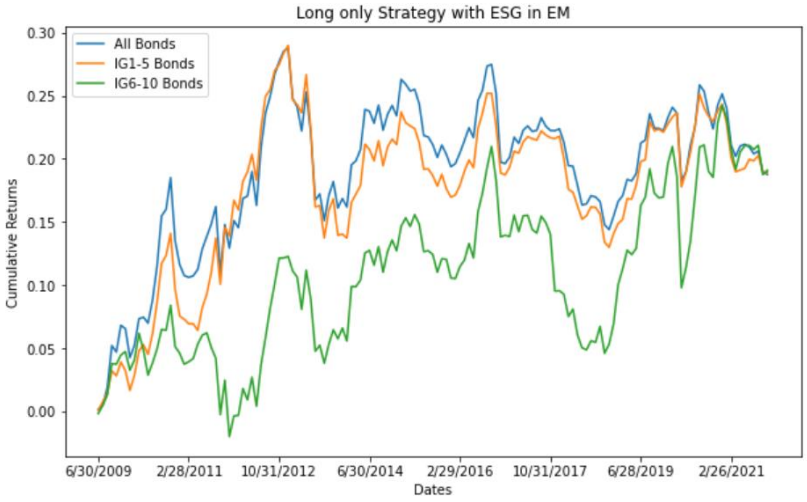
Developed Markets

Long-Only Portfolios: With ESG Integration	Long (All)	Long IG1-5	Long IG5-10
Annual Mean	1.05%	1.07%	1.04%
Annual Standard Deviation	3.13%	3.23%	2.66%
Annual Shape Ratio	33.65%	32.95%	38.98%
Maximum drawdown	-6.39%	-5.67%	-5.83%

Looking at the cumulative returns' graph for the Emerging Market after the inclusion of the ESG factor (Exhibit 25), there was no significant pullback in 2020 as has happened before, and there was a clear improvement in the trend. Furthermore, this improvement is more evident for Investment-Grade despite being relevant for the High-Yield subgroup (although there was a pullback, it was less aggressive than in the Long-Only strategy without the factor). Comparatively, for Developed Markets, the improvement was not so significant.

Exhibit 25 - Multi-Factor Long-Only portfolio applied to Emerging Markets with ESG Integration

Exhibit 26 - Multi-Factor Long-Only portfolio applied to Developed Markets with ESG Integration



Combining Emerging and Developed Markets

Analysing the results for a combined portfolio including the totality of bonds (1717) allows understanding the diversification benefits between the Emerging and Developed Markets' universes.

Investors seek Emerging Markets' securities for the high yield returns associated with the rapid growth experienced in these economies. In addition, investors can construct a portfolio that better manages risk by having exposure to both markets. One example of this is the faster recovery experienced by Emerging economies when compared to Developed countries, concerning the sovereign debt crisis in 2011, as highlighted in the macroeconomic review section.

A Long-Short strategy for a combined portfolio performs relatively well for credit specific portfolios, but it does not show any significant improvements when compared to the same strategy in either Emerging or Developed Markets. This is because the returns of these portfolios correlate nearly zero.

Interestingly, when including ESG in a Long-Short strategy in the global portfolio, both volatility and drawdowns increase, and returns decrease. Therefore, accounting for ESG in a global portfolio does not provide diversification gains, as filtering ESG scores is probably leaving out countries whose worse ESG performance correlates negatively to Developed countries, and both diversification benefits and higher returns of HY bonds are being disregarded.

When forming a new global portfolio, sovereigns will have a new ESG score. Since countries' ESG are computed based on percentile scores for the chosen categories, as explained in Section 6, Developed Markets will be at the top of ESG ranking and Emerging Markets at the bottom, on an aggregate level. As mentioned in the Literature Review (Section 2), this leads to the

exclusion of Emerging Markets' bonds in long positions as these will not be at the top 20% but rather on the bottom 20%, thus being only considered for a short position.

Exhibit 27 - Multi-Factor Long-Short with ESG integration applied to Emerging and Developed Markets Combined

Global Markets

Long-Short Portfolios: With ESG Integration	All bonds	IG bonds	HY bonds
Annual Mean	0.10%	0.33%	0.28%
Annual Standard Deviation	3.22%	2.02%	4.04%
Annual Shape Ratio	0.03	0.16	0.07
Maximum drawdown	-5.30%	-3.56%	-11.00%

Long-Short Portfolios: Without ESG Integration	All bonds	IG bonds	HY bonds
Annual Mean	0.06%	0.28%	1.23%
Annual Standard Deviation	1.38%	1.50%	3.51%
Annual Shape Ratio	0.04	0.19	0.35
Maximum drawdown	-2.75%	-3.04%	-9.40%

Cumulative returns shown in Exhibit 28 reiterate that ESG inclusion in a global portfolio takes away diversification gains and highlights the better performance of High Yield bonds in a Global portfolio without ESG. However, this HY Global portfolio does not represent diversification benefits, as most HY are from Emerging Markets, and only 1% of Developed Market bonds are HY bonds.

Exhibit 28 - Multi-Factor Long-Short portfolio applied to Combined Markets

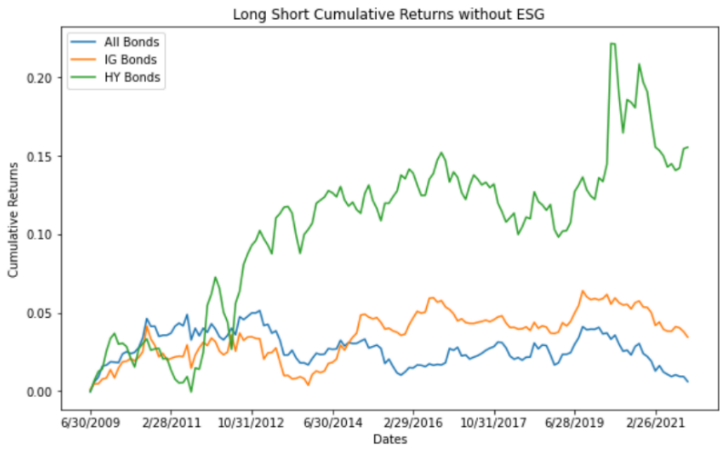


Exhibit 29 - Multi-Factor Long-Short portfolio applied to Combined Markets with ESG Integration

For the Long-Only strategy, combining both markets is not as significant, as the results of the combined portfolio were worse than the same strategy applied exclusively to Developed Markets' bonds. After including the ESG factor, we are longing the countries with the best ESG scores (mainly selecting securities of Developed Markets); as stated above, the diversification benefits are lost, and as described in Exhibit 30, the results of the combined portfolio were also worse.

Exhibit 30 - Multi-Factor Long-Only applied to Emerging and Developed Markets Combined

Global Markets

Long-Only Portfolios: With ESG Integration	All bonds	IG bonds	HY bonds
Annual Mean	0.98%	0.94%	0.57%
Annual Standard Deviation	3.05%	3.42%	3.37%
Annual Shape Ratio	0.32	0.28	0.17
Maximum drawdown	-5.74%	-5.65%	-6.50%

Long-Only Portfolios: Without ESG Integration	All bonds	IG bonds	HY bonds
Annual Mean	0.79%	0.85%	1.76%
Annual Standard Deviation	3.70%	3.62%	6.36%
Annual Shape Ratio	0.21	0.24	0.28
Maximum drawdown	-8.36%	-7.34%	-13.80%

Exhibit 31 - Multi-Factor Long-Only portfolio applied to Combined Markets

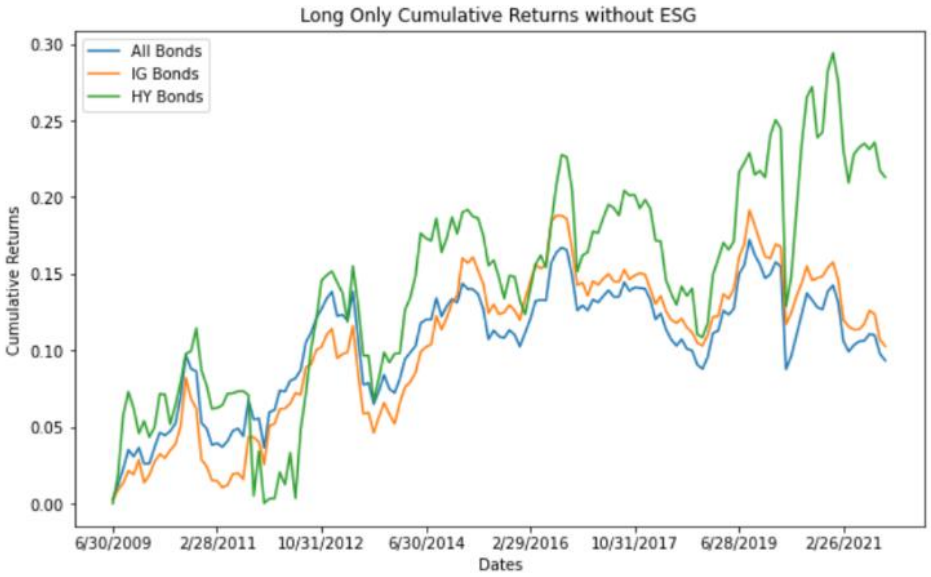


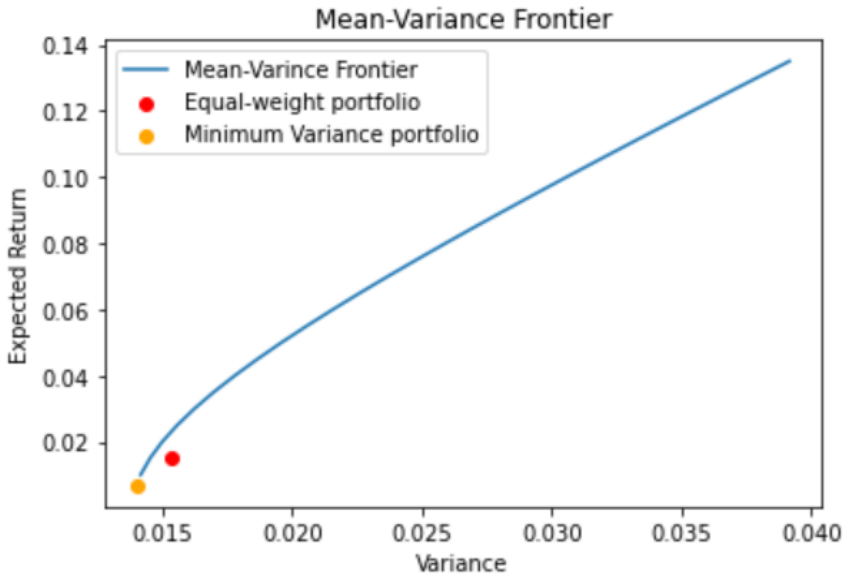
Exhibit 32 - Multi-Factor Long-Only portfolio applied to Combined Markets with ESG Integration

Mean-Variance Frontier Analysis

As shown in Exhibit 33, the chosen equal weight portfolio is not in the mean-variance frontier. This means that a portfolio could earn the same return for a lower level of risk. However, it is not realistic to assume investors can hold a portfolio in the mean-variance frontier as these include negative weights for some factors and as previously explained, it is not feasible to short-sell most sovereign bonds in Emerging Markets.

Interestingly, the equal weight portfolio has a return of 1.52% and a volatility of 1.53%, while the portfolio with the same return on the mean-variance frontier has a volatility of 1.45%. Despite the chosen portfolio not being in the mean-variance frontier, it is easy for investors to replicate it, as it offers a transparent approach to this Long-Only multi-factor portfolio with ESG and does not short-sell any factor portfolio.

Exhibit 33 – Mean-Variance Frontier & Equal-Weighted Multi-Factor Portfolio



Diversification benefits

Exhibit 34 – Factors' Descriptive Statistics

	Annual Return	Volatility	Sharpe ratio	Drawdown
Multi-Factor	1.53%	5.34%	0.29	-8.30%
Volatility	0.44%	9.67%	0.05	-16.48%
Value	0.67%	2.80%	0.24	-5.02%
Size	1.73%	5.74%	0.30	-9.23%
Momentum	2.45%	8.49%	0.29	-11.77%

As shown in Exhibit 34, the multi-factor portfolio does not improve individual strategies performance, as expected from factor correlations close to 1, limiting diversification benefits. To improve the multi-factor portfolio, we could have allocated a higher weight to Size or Momentum, which have the highest stand-alone Sharpe ratios, but we found that the equal weight method is more robust and reaps the benefits that all factors' premiums offer.

9. Conclusion

This group report aimed at analysing the collective impact in sovereign bond markets of four well-known factors: Momentum, Value, Size, and Low Volatility. Each of these factors was extensively studied in the reports developed individually by the authors. Additionally, an ESG factor was computed to provide innovative insights on its integration at the country level. Our sample comprises more than 250,000 bond month observations from Emerging and Developed countries across 13 years, from May 2009 to October 2021.

The results show that, in general, equally weighted portfolios of the four factors perform better than the benchmarks, even after the inclusion of the ESG factor. The more theoretical Long-Short strategies yield especially good Sharpe ratios when controlling for some degree of credit default risk, while the ESG integration significantly improves the performance of the

overall emerging and developed markets' portfolios. The four factors' impact on the more practical and realistic Long-only portfolios is also positive, showing more substantial results when dividing the samples into groups of credit ratings. The introduction of the ESG factor impacts the Long-Only portfolios similarly, as it mildly improves their Sharpe ratios. Combining all emerging and developed countries in the same sample did not yield significant differences, as the diversification benefits were limited by the high positive correlations between the two markets.

In terms of optimal weight allocation, a mean-variance frontier was computed and proved that the choice of equally weighting the four individual factor strategies was the best in terms of the trade-off between risk-adjusted returns and a realistic way of replicating them. For the same return, this portfolio is slightly riskier than the optimal one, but contrarily to the latter, it does not involve short-selling, which can be very complex and transaction costly in sovereign bonds, especially those from emerging markets.

Although the short period of the in-sample analysis may give rise to some time period bias, it is essential to point out that ESG measures are relatively recent, with reliable and relatively consistent data being available only for the past decade. Nevertheless, we find our results robust and strengthened when compared with out-of-sample data from the same period, as Barth, Hübel and Scholz (2019) also documented the impact of ESG performance on corporate credit spreads. The similarity in results of both in-sample and out-of-sample strategies reiterates the importance of accounting for ESG in various asset classes and the robustness of our findings.

Finally, we believe that this research and its innovativeness – mainly regarding the computation and integration of the ESG factor in sovereign bond markets – can guide socially conscious investors and portfolio managers looking to satisfy their clients' increasing demand for sustainable investing.

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Appendix

ESG Factor of the countries in the Emerging Markets sample, by year

Years	Angola	Argentina	Bahrain	Belarus	Brazil	Bulgaria	Chile	China	Colombia	Costa Rica	Croatia	Dominican Republic	Ecuador	Egypt
2008	4.70	4.73	5.28	4.65	5.53	5.75	6.17	5.11	4.64	6.17	6.00	4.32	4.33	3.76
2009	4.37	4.74	5.29	4.47	5.67	5.76	6.24	5.03	4.74	6.11	6.14	4.35	4.18	3.87
2010	4.12	5.08	5.14	4.44	5.70	5.49	6.25	4.96	4.83	6.07	6.19	4.39	4.14	3.85
2011	3.98	5.02	5.08	4.48	5.53	5.41	6.34	4.92	5.08	5.84	6.14	4.13	4.34	3.32
2012	4.50	4.79	5.12	4.28	5.46	5.50	6.43	4.80	4.91	6.12	6.28	4.24	4.39	3.34
2013	4.02	4.91	4.81	4.59	5.55	5.71	6.54	5.06	5.15	6.06	6.55	4.36	4.55	3.39
2014	4.36	4.90	4.94	4.63	5.33	5.68	6.47	5.22	5.50	5.99	6.66	4.51	4.43	3.37
2015	4.09	4.48	4.97	4.71	5.14	5.96	6.44	5.19	5.41	6.33	6.51	4.47	4.31	3.43
2016	3.98	5.03	4.87	4.94	5.27	6.03	6.73	5.27	5.24	6.25	6.34	4.47	4.72	3.86
2017	3.82	5.20	4.61	4.88	4.90	5.95	6.37	5.25	4.93	6.02	6.44	4.46	4.54	3.61
2018	4.02	4.83	4.50	5.35	4.89	6.03	6.47	5.21	4.99	5.91	6.35	4.41	4.48	3.76

Years	El Salvador	Guatemala	Hungary	Indonesia	Jordan	Kazakhstan	Kenya	Korea	Kuwait	Latvia	Lebanon	Lithuania	Mexico	Mongolia
2008	4.37	4.03	5.69	4.14	5.37	3.87	3.94	7.06	5.32	6.30	3.54	6.45	4.93	3.51
2009	4.44	4.03	5.76	4.22	5.18	3.91	4.16	7.23	5.33	6.33	3.71	6.30	4.92	3.26
2010	4.51	3.90	5.98	4.25	4.95	4.11	4.21	7.23	5.33	6.31	3.74	6.45	4.99	3.41
2011	4.68	3.92	5.93	4.37	4.86	3.86	4.24	7.23	5.20	6.68	3.52	6.68	4.95	3.62
2012	4.46	3.95	5.95	4.36	4.87	4.30	4.07	7.07	4.98	6.57	3.54	6.72	4.98	3.78
2013	4.66	4.19	6.20	4.72	4.92	4.52	4.68	7.37	4.86	6.91	3.77	7.01	5.12	3.93
2014	4.57	4.20	6.11	4.80	4.96	4.66	4.70	7.29	4.78	6.79	3.77	7.06	5.03	3.98
2015	4.82	4.08	6.38	4.69	4.74	4.57	4.54	7.35	4.70	6.67	3.91	6.94	5.28	3.39
2016	4.55	4.00	5.97	4.81	4.74	4.28	4.70	7.46	4.85	6.63	3.67	7.08	4.99	3.56
2017	4.47	3.81	6.29	4.64	4.91	4.28	4.40	7.02	4.67	6.53	3.68	7.01	4.81	3.70
2018	4.60	3.74	6.22	4.53	4.71	4.42	4.47	6.99	4.68	6.89	3.35	6.98	4.67	3.80

Exhibit 1 – ESG factor of Countries in the Emerging Markets sample

ESG Factor of the countries in the Emerging Markets sample, by year

Years	Morocco	Nigeria	Oman	Pakistan	Panama	Paraguay	Peru	Philippines	Poland	Qatar	Romania	Russia	Saudi Arabia	Serbia
2008	4.33	4.15	5.44	3.55	5.52	4.36	6.02	4.28	5.93	5.54	5.60	4.77	3.93	4.91
2009	4.52	4.31	5.50	3.70	5.55	4.31	5.90	4.33	6.06	5.50	5.40	4.52	3.77	4.86
2010	4.38	4.13	5.16	3.57	5.39	4.32	6.07	4.37	6.06	5.52	5.32	4.87	3.88	4.72
2011	4.35	4.11	5.20	3.50	5.54	4.11	6.03	4.31	6.14	5.54	5.24	4.88	3.93	4.72
2012	4.37	3.99	5.46	3.52	5.40	4.13	5.89	4.52	5.98	5.40	5.39	5.08	4.08	4.98
2013	4.50	4.45	5.34	3.62	5.63	4.43	6.11	4.73	6.40	5.29	5.92	5.15	4.16	5.13
2014	4.33	4.35	5.55	3.77	5.84	4.10	5.80	4.62	6.37	5.63	5.85	5.02	4.63	5.18
2015	4.49	4.15	5.54	3.73	5.98	4.29	5.94	4.66	6.79	5.24	5.95	4.73	4.35	5.38
2016	4.46	3.81	5.44	3.62	5.92	4.25	5.98	4.65	6.50	5.52	5.90	5.00	4.10	5.26
2017	4.41	3.66	5.03	3.23	5.66	3.81	5.81	4.10	6.30	4.96	5.89	4.80	3.99	5.20
2018	4.17	3.66	5.06	3.21	5.57	3.90	5.73	4.13	6.37	5.11	5.83	4.95	4.18	5.17

Years	Slovenia	South Africa	Sri Lanka	Trinidad & Tobago	Turkey	Ukraine	United Emirates	Uruguay	Venezuela	Vietnam
2008	7.01	5.05	4.86	5.26	4.43	3.91	4.89	5.97	3.96	5.31
2009	6.97	5.12	4.95	5.07	4.47	3.80	4.89	6.12	3.87	5.36
2010	6.92	5.17	4.91	5.20	5.04	3.97	4.82	6.12	3.72	5.24
2011	6.98	5.26	5.10	5.15	5.22	3.77	5.36	6.04	3.76	5.35
2012	7.00	5.12	5.10	5.10	5.04	3.71	5.36	5.87	3.74	5.23
2013	7.37	5.44	4.94	5.44	5.26	3.85	5.57	6.20	3.49	5.59
2014	7.37	5.21	5.31	5.34	5.14	3.67	5.44	6.06	3.48	5.60
2015	7.19	5.27	5.55	5.69	4.95	3.85	5.58	5.93	2.88	5.68
2016	7.57	5.47	5.30	5.53	4.80	3.95	5.18	6.10	2.77	5.87
2017	7.51	5.07	5.05	5.13	4.83	3.98	5.21	6.01	2.69	5.54
2018	7.35	5.04	4.82	4.81	4.75	3.82	5.08	5.96	2.68	5.54

Exhibit 2 – ESG factor of Countries in the Developing Markets sample

ESG Factor of the countries in the Developing Markets sub-universe

Years	**Australia**	**Austria**	**Belgium**	**Canada**	**Denmark**	**Finland**	**France**	**Germany**	**Greece**	**Ireland**	**Israel**	**Italy**
2008	4.88	5.31	4.31	5.11	5.14	5.78	4.63	4.93	3.07	4.08	3.55	3.64
2009	4.63	5.38	4.20	5.05	5.11	6.06	4.50	5.40	2.84	4.00	3.73	3.62
2010	4.78	5.28	4.57	5.04	5.07	6.06	4.55	5.33	2.77	4.00	3.66	3.53
2011	4.75	5.34	4.50	5.01	4.85	5.96	4.56	5.24	2.63	3.96	3.54	3.43
2012	5.01	5.39	4.36	5.08	5.38	6.04	4.63	5.31	2.88	4.22	3.98	3.52
2013	4.89	5.19	4.35	5.38	5.22	5.90	4.44	5.41	2.81	4.49	4.14	3.75
2014	4.75	5.03	4.37	5.13	5.38	6.04	4.26	5.62	2.50	4.49	4.12	3.56
2015	5.06	4.92	4.56	4.85	5.55	6.07	4.43	5.86	2.56	4.07	4.08	3.69
2016	4.56	4.86	4.01	5.12	5.00	5.93	4.33	5.67	2.54	4.05	4.14	3.54
2017	4.61	4.57	4.44	4.75	5.36	5.72	4.29	5.55	3.07	4.20	3.88	3.89
2018	4.61	4.57	4.44	4.75	5.36	5.72	4.29	5.55	3.07	4.20	3.88	3.89

Years	**Japan**	**Korea Rep**	**Netherlands**	**Norway**	**Portugal**	**Singapore**	**Spain**	**Sweden**	**Switzerland**	**United Kingdom**	**United States**
2008	4.96	3.72	5.67	6.09	4.39	4.94	4.27	6.74	6.20	4.61	3.95
2009	5.23	3.85	5.53	5.79	4.05	5.11	3.96	6.95	6.31	4.83	3.90
2010	5.27	3.85	5.79	5.95	4.16	4.94	3.96	7.04	6.19	4.61	3.80
2011	5.50	3.89	5.58	6.21	4.12	5.04	4.22	6.87	6.34	4.79	3.84
2012	6.01	4.01	5.57	6.29	4.35	5.31	4.03	7.22	6.50	5.02	4.08
2013	5.84	4.08	5.39	6.16	4.43	5.32	4.35	7.02	6.64	5.21	4.10
2014	6.03	4.13	5.55	6.12	4.24	5.32	4.48	6.94	6.46	5.26	4.41
2015	5.93	4.28	5.56	5.94	4.50	5.13	4.32	7.05	6.47	5.17	4.06
2016	5.61	4.05	5.26	5.89	4.34	4.78	4.24	6.67	6.02	4.85	4.18
2017	5.49	3.73	5.23	5.80	4.42	4.82	4.30	6.64	6.21	4.59	4.33
2018	5.49	3.73	5.23	5.80	4.42	4.82	4.30	6.64	6.21	4.59	4.33