Diversifying Risk and Beating the Market through ESG

Evidence from Latin-America

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Abstract

This paper examines the case of ESG investing in the Americas by analyzing the historic performance of traditional benchmarks in key financial markets and comparing them against selected ESG Indexes. The proposed framework evaluates different metrics that consider investment returns and the degree of risks taken to achieve them in order to determine whether the growing trend underlying ESG efforts provides a suitable investment alternative in the United States and Latin American equity markets. The study shows mixed evidence in the analyzed period, but it cannot be denied that markets are assigning value to the endeavor of compliance with ESG guidelines. The paper also tests for macroeconomic and investment factors that could explain ESG return spreads across countries.

Research Approach

Design – The study presents a quantitative empirical analysis across a period of 6 years and 3 months (2015-2021)[1], comparing the financial performance of market benchmark indexes and selected ESG indexes in the USA, Mexico, Colombia, Brazil, Chile, and Peru. Each 1-year period is observed individually as well as a whole, using 4 key metrics for overall performance assessment (Annual and Holding Period Returns, CAGRs[i], and Volatility), and 3 others to measure risk-adjusted returns (Sharpe, Sortino and Omega Ratios). These latter are examined side-by-side (ESG vs. Benchmarks) using spreads and ratios for every country, for every period. Moreover, the systematic risk of ESG indexes is observed via Bloomberg Terminal functions to examine the effects of ESG Index considerations in diversification. Finally, regression-based models are applied to further investigate the magnitude in which macroeconomic and investment factors affect said spread. Additional support information presents correlation analysis between ESG indexes and their Benchmarks, correlation against core market assets, investment factors and normalized returns comparisons.

Objectives – The purpose of this research is to address essential queries that pose significant interest to potential investors in the ESG sector. The central question being: (i) Can ESG Indexes outperform their Market Benchmarks? This entails a series of support questions: (ii) Historically, have ESG Indexes attained better risk-adjusted returns than the market? (iii) Is there a greater inherent risk in ESG Indexes than their Benchmarks? (iv) Does ESG investing work in Latin-American markets (Brazil, Mexico, Chile, Peru, Colombia) and (v) What macro and investment factors could explain ESG spreads across LATAM countries?

Practical Implications – Given that ESG Indexes constitute a substantial number of companies with high market capitalization and market liquidity, this research presents relevant practical implications on how potential LATAM capital market investors develop their regional investing and funding strategies.

[1] As this paper goes to print, in the early days of 2023, we manage to extend the analysis into the 31st of December 2022 an even though the results are consistent there is a slight change in the list of countries that improved their benchmark. We will comment about this in the conclusions section.

Paper Originality – Although ESG is not a mandatory metric in financial reporting, a considerable number of companies disclose this type of information in sustainability reports to reveal the company's performance in matters related to environmental, social, and other economic areas for stakeholders. ESG has had increasing popularity as investors begin to weight in non-financial factors as part of their investment processes to identify new growth opportunities with different types of risks. This study portrays the first attempt to evaluate ESG Indexes' profitability and risk in Latin-America.

Keywords – ESG Indexes; Benchmark (BM) analysis; volatility; risk-adjusted return, factor analysis.

Topic Introduction

There has been an effort -many decades ago- to find ways to make the corporation compatible with a sustainable future for all. Quality controls in its many forms and philosophies and corporate governance in its many faces and tools are examples of this uncoordinated labor. In recent years though, it has been the time of the ESG movement (Environmental, Social and Governance) to exert the attention of both markets and thinkers and try to concoct a standardized measurement and package some kind of device that would enable a comparison among companies in their attempt to "better the world and still make money".

This work is still in progress but there are at this point, a good number of half-way goals achieved by this new yet amorphous industry -the ESG certifying industry- and markets have also captured the imagination -and the returns- of these novel ideas. There are many indicators that could describe the "E" part, and, in many senses, there is no latitude of discussion as of how many litters or tons of damaging material you could or should dump into rivers, the air or crop fields and for that reason those variables are very manageable. For the "G" part, even though more ample in its origins and its ambitions (i.e., c-suite executives' independence or how clear are the objectives to achieve performance bonuses for middle managers), the evidence, the statistics and the data is known and more or less disaggregated and probed by financial scientists since the 60´s in many countries. Because of the extensive amount of information related to a company's governance, it can be said that this factor can be measured in a closely standardized fashion.

The problem comes with the "S" part. As all dimensions, the social is embezzled with definitions and classifications, but most of them -in this particular case- are furthermore charged with politics, which is moreover country-specific. There is just not enough clarity and independence from partiality in this field, on the contrary, it is hard to imagine a discussion -even at the scientific level- without a number of prejudice diversions. What should be the poverty line, or how to define "social impact" or the "circle of influence" of some company, either geographic or in other more encompassing terms.

In lieu of these points, it is fair and useful to draw a mental map of questions regarding the validity of any conclusion achieved through the ESG topic. The first fork occurs at this double junction: Does ESG as an endorsement produce enough gravity attraction on the markets such that excess returns are gained by those that hold it? (And this paper is an

attempt to answer that portion). The second one is this: Does ESG hold value? (Or is it a useless and empty bundle of opaque measurements? Is it only a money machine for certifiers and all parties involved?). Note that even if markets assign value to this corporate effort, that does not mean that the value is real or sustainable (fads can coexist with empty promises or outright lies about compliant directives, as the so-called trend of "greenwashing").

It could also be that even though well-meaning efforts by the companies are applied to strategy, the investment is wrongly done by brokers, mutual funds, and shallow trend-seekers. Moreover, we have to open a new branch towards incorrect measurement (either voluntary or process-led): perhaps a consultant is fraudulent or questionnaires and indexes are not (or cannot be) standardized across nations; industry classification could be wrong or vary by country, which gives way to the last split of logic: What if (because of not enough testing time or diverging philosophies of the core group of scientists) the data does not produce the needed information (for example, what happens if we are capturing the exit KPI´s[ii] but the richness in true impact is in the follow-up statistics of the firm and its ecosystem?).

All of these possibilities could present a very murky picture. The market could be paying for the perception and not the matter-of-fact content of the applied policy itself and lastly, what if companies and investors develop "disclosure fatigue" and all these endeavor results in a feel-good but finally futile search for virtue? In this paper we examine the question of return as an asset class and any conclusion will bestow answers with the evidence at hand (a period in the life of ESG data published up to this point) but that does not rule out future scenarios in which the market awakens to the true (and maybe unfitting) substance underneath each index, and the performance of ESG-heavy funds show distrust. If ESG spreads are positive, it could be explained by underlying macro or investment factors, such as size or the technology content in it and not necessarily an improvement in the ESG rating itself. Any reading that is captured in this piece, therefore, should be taken with these circumstances in mind.

Literature Review

Dating back to the 1960s, an early form of ESG became part of investment decision-making and portfolio strategies through simple exclusions of stocks and industries based on business activities such as tobacco production and association with the apartheid regime in South Africa (MSCI, 2022). Today, a mass incorporation and evolution of ESG metrics has redefined the landscape of socially responsible investing, thus resulting in multiple theoretical and practical studies around the topic during the course of the years, specifically more recent ones. In instances, the very essence of ESG has been questioned by academics. Such is the case of Maximillian Horster who disagreed with the basic hypothesis that ESG investing can bring positive environmental and social outcomes that eventually reflect into economic growth. Undoubtedly, there has been a surge in sustainable investments around the world, however, as stock exchanges have endured a "green" revolution during recent years, a significant positive effect in sustainability practices is yet to be seen. Horster's study

states that by the year 2018 low-carbon investments had peaked along unprecedented levels of global greenhouse gas emissions, questioning the reversal of harmful environmental trends on the investment front. In his research he discusses that there is a fundamental flaw in the basis of ESG investing and its theory of change (Horster, 2021). By rotating to an ESG strategy, investors aim to de-risk their portfolio from a specific set of factors. Nevertheless, i.e., by not investing in non-ESG institutions such as weapon companies, the number of companies that produce weapons is not reduced. If enough investors sell stocks from these types of companies their prices might drop, only causing them to be undervalued and possibly make them consider going private, yet it is still unlikely that they will cease operations. It was concluded that although good intentions exist within the financial industry to contribute to a positive environmental change, there is a poor execution behind it.

In a more practical approach, a study by the NYU Stern School of Business presented a thorough review of more than 1,000 financial-performance-related papers published between 2015-2020 regarding ESG. Overall, studies show a positive correlation between ESG performance, operational efficiencies, stock performance and lower cost of capital. Additionally, recent evidence suggests that ESG focused businesses is synonymous with quality management and improved returns (Whelan, Atz, and Clark, 2021). Based on the corporate studies (focused on metrics such as ROE, ROA, and stock prices), a strong positive relationship was found between ESG and said operational metrics. On the other hand, investment studies (focused on risk-adjusted characteristics such as Sharpe Ratios and alphas) were found to present less definite results with 59% of them showing similar or slightly better performance of ESG investments compared to conventional ones, while 14% found definite negative results. Amongst the several statements presented in the paper, it was concluded that ESG investing returns are often indistinguishable from conventional investing returns, also that the financial performance differences between these two is more visual in the long-term, and that ESG investing provides notable downside protection during socio-economic crises.

With relation to the downside protection during socio-economic crises, the hypothesis that ESG Indexes possess safe-haven properties was tested from the period of February 5th, 2020, to January 18th, 2021, by examining the correlation between the Daily Global COVID-19 Fear Index (GFI) and several ESG Indexes' returns. Findings concluded that ESG Indexes do in fact present a risk-averse investment opportunity for portfolio diversification during times of global economic crisis due to global pandemic (Rubbaniy, Khalid, Ali, Naveed, 2021). During the pandemic, most indexes examined in the study displayed greater returns than market benchmarks. Nevertheless, it is worth noting that the "safe-haven" properties noticed during this 2021 study are extremely limited to the COVID-19 period only and it would be incorrect to assume that said behavior will remain active if a similar sanitary or otherwise systemic event took place in the future.

The financial performance of ESG-related assets has also been a subject of adverse reviews. In the research paper, "Environmental, Social and Governance (ESG) Scores and Financial Performance of Multilatinas", a statistically significant negative relationship is observed between the ESG score and financial performance of a company. This result was

observed by analyzing 104 multinational companies from Mexico, Chile, Colombia, Brazil, and Peru between 2011 and 2015. The study adds that the best ESG score companies in LATAM tend to be less profitable since "costs related to the implementation of ESG initiatives are not reflected in a company's [financial performance] because these initiatives are not performed in the correct manner or because there is not enough institutional support to render them more visible, thus not ensuring approval from stakeholders. Alternatively, when Multilatinas make high investments in ESG, they may sacrifice their cash flow and divert resources required for their operation, decreasing their performance" (Duque-Grisales, and Aguilera, 2019). Evidence presented in the study is, however, conflicting with the findings of Miralles-Quirós et al. in "The value of relevance of environmental, social, and governance performance: The Brazilian case", which found that ESG has a positive relationship with Brazilian companies' financial performance.

Finally, the analysis presented in "Can ESG Investing Beat the Market and Improve Portfolio Diversification? Evidence from China" (Dai, 2021), show that investing in ESG equity indexes can increase risk-adjusted returns and improve portfolio diversification for the case of China, nevertheless ESG indexes in China have a much larger sample size compared to LATAM Indexes, which could influence the measurements of diversification potential vs the case in our region. This paper aims to analyze the performance of ESG related indexes for key capital markets in LATAM, and replicates some of the questions and methodology of Dai´s paper because to this day, slight attention has been paid to ESG and financial performance in Latin American markets.

Analytical Framework

Data description and time-series characteristics

This first section describes the characteristics of the ESG and Market Benchmarks data base used throughout the study. The selected Latin-American and American markets come from the Sustainable Stock Exchanges (SSE) Initiative, a partnership program developed by the United Nations and organized by the United Nations Global Compact (UNGC), the United Nations Environment Program – Finance Initiative (UNEP FI), the United Nations Conference on Trade and Development (UNCTAD), and the Principles for Responsible Investment (PRI) network. Its purpose is to provide an electronic platform for investors, companies, and relevant stakeholders to inform on global ESG issues and promote sustainable investments.

The SSE Initiative manages an extensive Stock Exchange Database that records information about ESG related topics from 115 exchanges, including representative ESG Indexes which were used to analyze Latin-American markets. **Table 1** presents a sample of ESG categories reported by the SSE Initiative for the six exchanges in the research's scope. These categories detail whether each market provides an annual sustainability report, requires ESG reporting as a listing rule, has written guidance regarding ESG reporting, offers ESG-related training for stakeholders, has sustainability-related indexes, has a sustainability bond listing segment, and if there is a mandatory minimum rule for women on company boards. It is worth noting that all six exchanges have sustainability-related indexes which

include ESG indexes, as well as specific themes such as low carbon indexes and other general non-financial reporting factors. The ESG Indexes used in this study are recorded in the sustainability-related indexes section of each equity market. These are the S&P 500 ESG Index (SPESG) for the United States, the Corporate Sustainability Index (ISE) for Brazil, the Colombian Recognition Index (COLIR) for Colombia, the S&P/BMV Total Mexico ESG Index (EE0000) for Mexico, the Good Corporate Index (SPBLBGPT) for Peru, and the Dow Jones Sustainability Chile Index (DJSCLCP) for Chile. Additional information regarding these indexes is shown in **Table 2**. Even though the Mexican and American ESG Indexes have very recent launch dates, S&P[iii] Global (their equity management company), provides backward data assumptions for the indexes through hypothetical back-tests based on the indexes' methodologies in effect during their launch dates. For this study's purposes, the period of information begins in September 2015, launch date of the DJSCLCP, and ends in December 2021.

Table 1. Sustainable Stock Exchanges (SSE) initiative in Latin-America, 2021.

Stock Exchange	SSE Partner Exchange	ESG reporting as a listing rule	Has written guidance on ESG reporting	Offers ESG related training	Sustainability-related Indices	Has sustainability bond listing segments	Women on boards mandatory minimum rule
USA	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Brazil	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**No**
Chile	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**No**
Peru	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**No**
Colombia	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**No**
Mexico	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**No**

Table 2. ESG selected equity indexes in LA.

Country	Ticker	ESG Index	Constituents	Market Cap. Local***	Currency	Market Cap. USD	Launch Date
USA	**SPESG**	**S&P 500 ESG Index**	**309**	**$26,482,059**	**USD**	**$26,482,059**	**28-Jan-19 ***
Brazil	**ISE**	**Corporate Sustainability Index**	**41**	**$155,700,000,000,000**	**BRL**	**$325,616,000,000**	**15-dic-05**
Colombia	**COLIR**	**IR Recognition Index**	**29**	**$364,000,000,000,000**	**COP**	**$96,560,000,000**	**31-ene-08**
Mexico	**EE0000**	**S&P/BMV Total Mexico ESG Index**	**29**	**$4,083,000,000,000**	**MXN**	**$246,000,000,000**	**22-Jun-20 ***
Chile	**DJSCLCP**	**Dow Jones Sustainability Chile Index**	**26**	**$86,697,021**	**CLP**	**$102,834**	**28-sep-15**
Peru	**SPBLBGPT**	**Good Corporate Index**	**9**	**N/A**	**PEN**	**N/A**	**7-Jan-08 ** **

*Previous information obtained with provided back-tests. **Index was discontinued on December 31, 2021.
*** Data as of Jun 03, 2022

Table 3 sets each country's ESG Index and Benchmark side by side with a summary of key statistical variables to better understand each of them. The latter represent the main stock market indexes for each country which serve as the index baselines for the construction of their respective ESG Indexes. Comparing each other will help analyze ESG's risk-reward characteristics versus an accurate approximation of their investment universe. In the table, the simple returns portray the overall performance of the asset, the standard deviation is equivalent to the asset's volatility or risk, and the correlation reveals how closely related the indexes are to each other.

The information indicates that ESG in Brazil and Chile have less volatility than their BMs and lower returns over the 2015-2021 period, contrary to ESG in USA and Mexico which have higher volatilities and greater returns than their BMs. Colombia has less volatility than its benchmark but higher returns, while the exact opposite is shown in Peru with higher volatility and lower returns. This first overview shows that there are split results in volatility and simple returns when comparing ESG and BM Indexes in the selected geographies. All correlations between ESG and BM are strong and positive, the lowest being in Peru with a 0.89 and the highest in the USA being close to one.

Table 3. Statistical Overview: ESG vs. BM from September 2015 – December 2021

Country	ESG	BM	Simple Return ESG	Simple Return BM	Stdev ESG	Stdev BM	Correlation
USA	SPESG	S&P 500	164%	153%	18.30%	18.23%	0.9982
Brazil	ISE	BVSP	66%	138%	24.65%	26.82%	0.9465
Colombia	COLIR	COLCAP	22%	17%	18.52%	18.76%	0.9923
Mexico	EE0000	IPC	39%	26%	16.46%	15.96%	0.9381
Chile	DJSCLCP	SPIPSA	-8%	18%	20.16%	20.44%	0.9876
Peru	SPBLBGPT	SPBLPGPT	100%	113%	18.80%	17.56%	0.8943

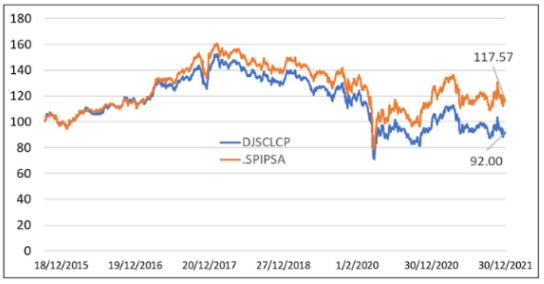
*Only Peruvian Indexes include dividends

An overview of the normalized ESG and BM Indexes' returns (blue and orange lines respectively) for each geography is presented in **Figure 1**. The American, Colombian, and Mexican ESG indexes outperform their benchmarks, while the Peruvian, Brazilian, and Chilean lag behind them.

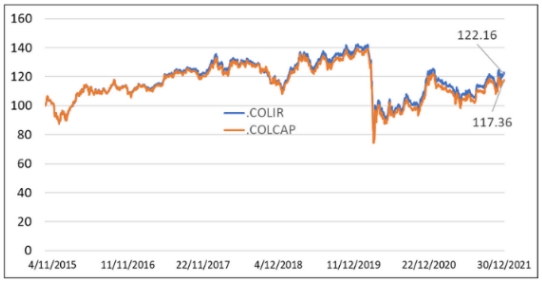
Figure 1 (Below). ESG Index Performance vs. Benchmark Normalized Performance: Graphical Overview

USA

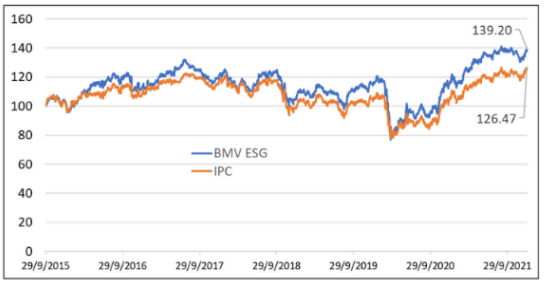
BRAZIL



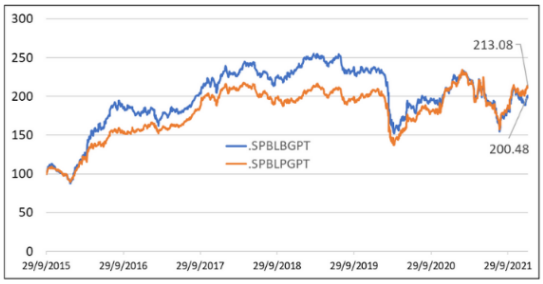
CHILE



COLOMBIA



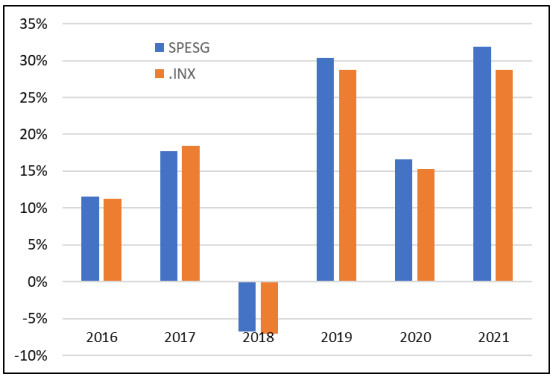
MEXICO



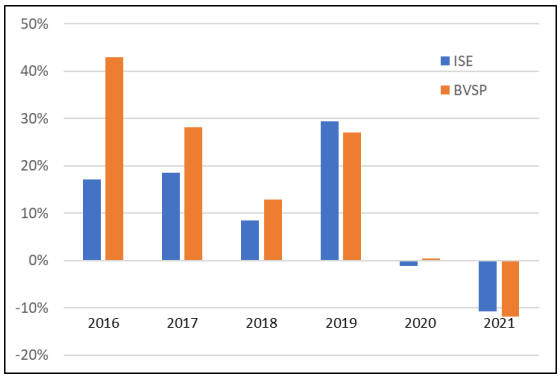
PERU

The following bar graphs in **Figure 2** show the returns of every ESG and BM Index per country for the 2015-2021 period, and by year for each complete year (2016-2021). For the overall period only the United States, Colombia, and Mexico outperform their base indexes. ESG in Chile was the only index which presented a loss during said timeframe.

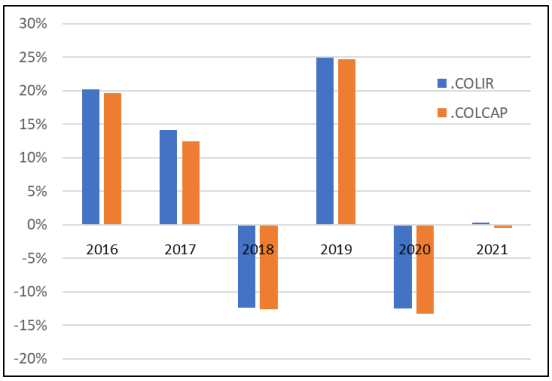
Figure 2 (Below). ESG Index Performance vs. Benchmark Simple Returns per Period: Graphical Overview



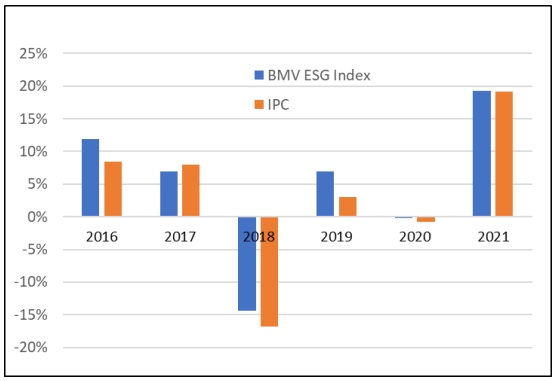
USA



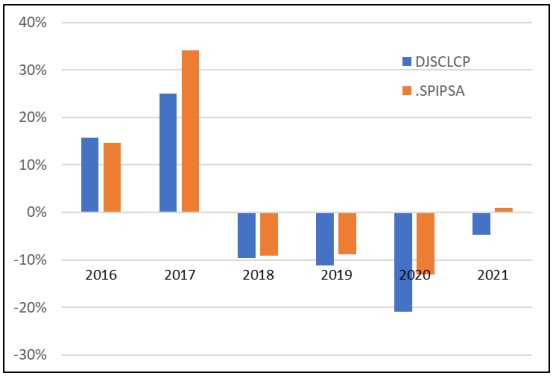
BRAZIL



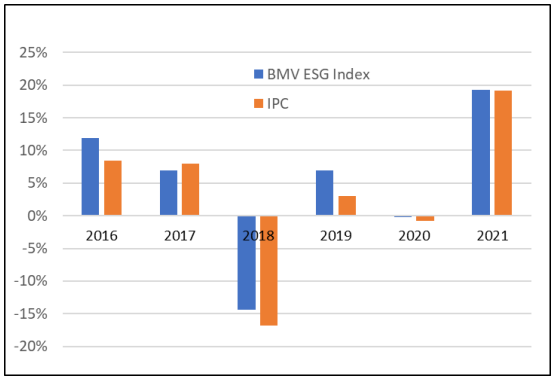
COLOMBIA



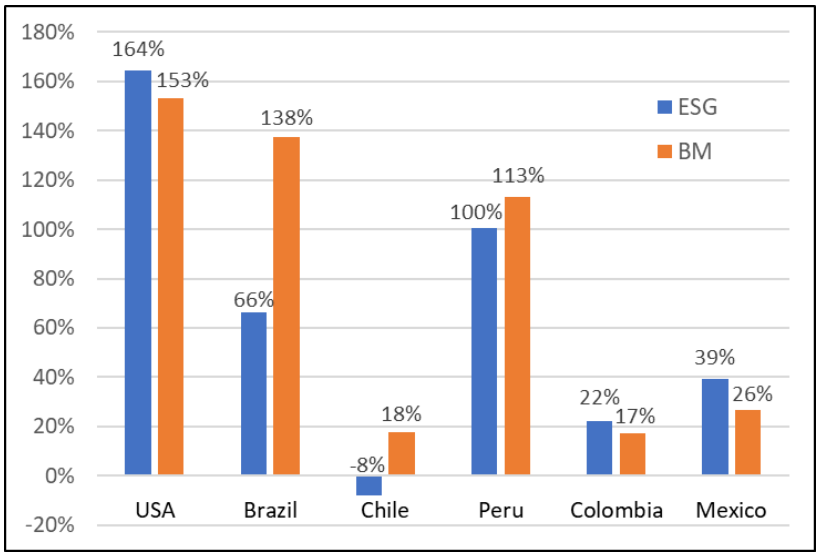
MEXICO



CHILE



PERU



To further compare all six ESG Indexes with their corresponding Benchmarks, three key ratios help better understand their risk and return characteristics: Sharpe Ratio[iv], Sortino Ratio, and Omega Ratio. The first is given by dividing the annualized return of an asset minus a risk-free rate, over the volatility of said asset. It describes the excess return received per unit of volatility. The risk-free rate is often based on a government's debt instrument such as 2-year, 5-year, or 10-year sovereign bonds yield. All ratios in the study were calculated using the 10-Year Bond Yield of each country: CO10YT for Colombia, PE10YT for Peru, CL10YT for Chile, BR10YT for Brazil, US10YT for the USA, and MX10YT for Mexico.

Another way of measuring risk-adjusted returns is the Sortino Ratio, a variation of the Sharpe Ratio. While the Sharpe ratio penalizes returns with a risk-free rate and the asset's overall volatility regardless of its positive or negative effects on price, the Sortino Ratio only accounts for the downside risk of an asset (Sortino & Price, 1994). By focusing on the negative deviation, the Sortino Ratio provides a better investment view of the risk-adjusted performance of an asset since any upside volatility represents a benefit for investors and thus shouldn't worry about its effects. The ratio is defined as an asset's returns minus a risk-free rate, divided by the assets downside deviation. In other words, it indicates the excess return received per unit of downside risk. Because of this, Sortino Ratios have higher results than Sharpe Ratios.

The third risk-adjusted measurement used to analyze the Indexes is the Omega Ratio[v] which weights the risk-return of an asset to identify the chances of obtaining positive vs. negative returns in given periods. This Ratio uses a minimum acceptable risk (MAR) to obtain the cumulative excess returns, which in this case were the risk-free rates used in the Sharpe and Sortino Ratios. Given that the ratio divides the weight of the gains over the weight of the losses, a result over 1 or higher implies a greater probability of obtaining positive returns.

Data Observations and Discussion

Table 4 shows the results of all 3 ratios for each country's ESG and Benchmark Indexes for the 2015-2021 period. These were appraised with three different comparison methods as seen in **Tables 5, 6, and 7**. The spread is a simple difference between the ESG and the BM, resulting in a positive value if the ESG Index performance is better. The ratio is the quotient of the ESG over the BM, resulting in a value over one if the ESG Index outperforms its BM. Lastly, the simple return difference, although not directly comparing the Sharpe, Sortino, and Omega Ratios, describes the overall performance of the indexes (ESG-BM return) in each given period. Information regarding yearly periods is presented in the **Appendix** section. In most cases all results are congruent with each other: i.e., a positive spread has a ratio over one and an ESG Index with a greater simple return than its benchmark. The opposite occurs when the benchmark outperforms the ESG Index, however, there are two instances in which this behavior does not occur and will be addressed later on this section. Additionally, **Table 8** display the holding period (the simple return of a dollar if it had been invested at the beginning of the period) and compounded annual growth rate (CAGR) for every asset in the general period. Yearly information is included in the **Appendix**.

Table 4. Sharpe, Sortino and Omega Ratios – 2015-2021 Period

Country	Sharpe Ratio ESG	Sharpe Ratio BM	Sortino Ratio ESG	Sortino Ratio BM	Omega Ratio ESG	Omega ratio BM
USA	0.9218	0.8786	1.1385	1.0822	1.1897	1.1811
Brazil	0.0425	0.3132	0.0466	0.3613	1.0071	1.0515
Chile	-0.1688	0.036	-0.2391	-0.0076	0.9677	1.007
Peru	0.5001	0.5846	0.65	0.7438	1.0905	1.1084
Colombia	-0.088	-0.1218	-0.1062	-0.1518	0.9824	0.9761
Mexico	-0.0019	-0.1094	-0.0071	-0.1439	0.9997	0.982

Table 5. ESG vs. BM, Sharpe Ratio Comparison Methods– 2015-2021 Period

Country	Spread (ESG-BM)	Ratio (ESG/BM)	Simple Return Difference (ESG – BM)
USA	0.04	1.05	12%
Brazil	-0.27	0.14	-71%
Chile	-0.2	---	-26%
Peru	-0.08	0.86	-13%
Colombia	0.03	---	5%
Mexico	0.11	---	13%

*For **Tables 5,6, and 7**: A green color means that ESG performed better than its BM.

Table 6. ESG vs. BM, Sortino Ratio Comparison Methods– 2015-2021 Period

Country	Spread (ESG – BM)	Ratio (ESG/BM)	Simple Return Difference (ESG – BM)
USA	0.06	1.05	12%
Brazil	-0.31	0.13	-71%
Chile	-0.23	---	-26%
Peru	-0.09	0.87	-13%
Colombia	0.05	---	5%
Mexico	0.14	---	13%

Table 7. ESG vs. BM, Omega Ratio Comparison Methods– 2015-2021 Period

Country	Spread (ESG – BM)	Ratio (ESG/BM)	Simple Return Difference (ESG – BM)
USA	0.01	1.01	12%
Brazil	-0.04	0.96	-71%
Chile	-0.04	0.96	-26%
Peru	-0.02	0.98	-13%
Colombia	0.01	1.01	5%
Mexico	0.02	1.02	13%

Table 8. Total Return if you invested $1 dollar since Sept'15- Dec '21, and CAGR

Country	ESG		Benchmark		Difference
	Holding Period Return	CAGR	Holding Period Return	CAGR	(HPR - ESG - BM)
USA	2.64	15.40%	2.53	14.61%	0.12
Brazil	1.66	7.78%	2.38	13.50%	-0.71
Colombia	1.22	2.84%	1.17	2.22%	0.05
Chile	0.92	-1.41%	1.18	2.37%	-0.26
Peru	2.00	17.52%	2.13	19.19%	-0.13
Mexico	1.39	6.49%	1.26	4.57%	0.13

Throughout all 3 Comparison Methods' tables, the USA's, Colombia's, and Mexico's ESG Indexes maintain slightly higher spreads and ratios than their benchmarks meaning that ESG in these countries: (1) Receive better excess return for additional overall volatility, (2) Receive better excess return for additional downside volatility, and (3) are less likely to experience negative returns than their BMs. It can be noted that the outperformance or underperformance of each ESG index is the same within all 3 ratios. As mentioned before, most of the behavior seen in the spread, ratio, and simple returns are congruent with each other except in 2018 for Colombia and 2021 for Brazil (refer to the **Appendix** for yearly information). In both cases, while the Sharpe, Sortino, and Omega ratios of their ESG Indexes are beaten by their Benchmarks, the ESG returns are greater. The aforementioned apparent anomaly can be explained by the Indexes' volatility. When two assets have similar positive returns, the one with the highest volatility will have a lower Sharpe ratio since it displays a worse risk-return relationship. On the other hand, when two assets have similar

negative returns, the one with *lower* volatility will have a lower (worse) Sharpe ratio because its risk degree makes up for little to none probability of positive reward. The same effect affects the Sortino and the Omega ratios given that downside volatility is directly represented in the former, and overall volatility is indirectly represented in the latter through return distributions. The situation for Colombia and Brazil can be better understood with an example calculation of the Sharpe ratio in **Table 9**. Returns are marginally less negative for ESG, and such is their volatility, thus penalizing the ratio. The same can be said for the Sortino and Omega Ratios for these countries in their respective periods. Also, each country's simple returns per period can be seen in **Table 10** below and Rolling Returns for three-, six- and twelve-month sample windows can be found in the **Appendix** (**A.6**), showing consistent results in our conclusions (i.e., that USA, Colombia and México beat their BM during most of the tested period and their ratios, although not showed, also did).

Table 9. Sample Sharpe Ratio Calculation, Colombia 2018 & Brazil 2021

Data	Colombia 2018		Brazil 2021	
	ESG	BM	ESG	BM
Annualized Average Return	-11.98%	-12.09%	-10.11%	-10.19%
Average Risk Free Rate (10Y Bonds)	7.00%	7.00%	9.67%	9.67%
Annualized Volatility	12.13%	13.02%	19.72%	20.98%
Sharpe Ratio 2018	**-1.5647**	**-1.4662**	**-1.0029**	**-0.9464**

Table 10. ESG vs. BM, Simple Returns

Country	USA		Brazil		Chile		Peru		Colombia		Mexico	
Year	ESG	BM	ESG	BM	ESG	BM	ESG	BM	ESG	BM	ESG	BM
2015-2021	164.48	152.90%	66.44%	137.50%	-8.00%	17.57%	100.40%	113.10%	22.16%	17.36%	39.20%	26.47%
2016	11.60%	11.20%	17.20%	42.90%	15.80%	14.60%	81.00%	59.00%	20.10%	19.60%	11.90%	8.40%
2017	17.70%	18.40%	18.50%	28.20%	25.00%	34.10%	22.80%	28.60%	14.10%	12.50%	6.90%	8.00%
2018	-6.70%	-7.00%	8.50%	12.80%	-9.60%	-9.10%	5.70%	-4.60%	-12.40%	-12.60%	-14.40%	-16.80%
2019	30.40%	28.70%	29.40%	27.10%	-11.10%	-8.90%	-0.20%	6.00%	24.90%	24.70%	7.00%	3.00%
2020	16.60%	15.30%	-1.20%	0.40%	-20.90%	-13.10%	-11.90%	0.90%	-12.50%	-13.30%	-0.20%	-0.80%
2021	31.80%	28.80%	-10.70%	-11.80%	-4.70%	1.00%	-5.70%	0.30%	0.30%	-0.50%	19.30%	19.20%

The Sharpe, Sortino and Omega Ratios for all ESG Indexes in descending order are presented in **Table 11**. In It, it can be observed that even though Peru and Brazil have greater ratios than Mexico and Colombia, they do not manage to outperform their Benchmarks. USA's, Peru's, and Brazil's ESG Indexes have positive ratios with all their Omega ratios being considered acceptable as they are greater than 1, implying that the probability of upsides in the asset are more likely than downsides for the given period. However, all their Sharpe ratios are considered suboptimal, being less than 1, meaning that there is little excess return gained per unit of volatility.

Evidently, all country's Sortino ratios are higher than their Sharpe ratios since positive volatility is disregarded in the calculations; only the USA's ratio results in an

acceptable value (greater than 1). Mexico's Colombia's, and Chile's results are marginally negative for the Sharpe and Sortino ratios, meaning that the risk-free asset (their 10-year sovereign bonds) had greater returns than the ESG Indexes. Because of this, their Omega Ratios reflect a value lower than 1 with higher probability of obtaining downsides through the period. Chile's ESG Index experienced the worst performance when compared to its BM Index, other countries, and its risk-free rate.

Table 11. All 3 Efficiency Ratios for all countries presented in descending order

Country	Sharpe ratio ESG	Sortino ratio ESG	Omega ratio ESG	BM Outperformance
USA	0.92	1.14	1.19	Yes
Peru	0.5	0.65	1.09	No
Brazil	0.04	0.05	1.01	No
Mexico	-0.002	-0.01	0.9997	Yes
Colombia	-0.09	-0.11	0.98	Yes
Chile	-0.17	-0.24	0.97	No

Figure 3 exhibits a color-coded diagram illustrating the periods in which ESG had better Sharpe, Sortino, and Omega ratios than its benchmark (green), and the times where it didn't (red). This data summary, together with the simple returns in **Table 10**, help answer the first two questions of the research paper. Cleary, from a risk-adjusted return and simple return point of view, the USA's, Colombia's, and Mexico's ESG indexes outperform their counterparts in almost every occasion.

Conversely, the benchmark indexes in Brazil, Chile, and Peru beat ESG most of the time. Brazil, Peru, and Colombia were pioneers in developing ESG Indexes in Latin-America, however Colombia, and the newly instated Total Mexico ESG Index in 2020, seem to be the only ones which consistently beat their benchmarks in the region. It can also be noted that USA's ESG Index undoubtedly distinguishes itself from the LATAM indexes, achieving significantly higher ratios (**Table 11**) and a triple digit growth over the 2015-2021 period (**Table 10**).

This split result might call into question the value of ESG investing in half of the study's countries. It might also suggest that the methodology and rebalancing of the components found in the ESG indexes that regularly underperform versus market standards should be reconsidered to make them a worthy investment[vi]. Perhaps this issue could specifically be further analyzed in Peru, given that its ESG Index, the Good Corporate Index (IBGC), has been recently retired in December 2021 and replaced with an improved version called S&P/BVL Peru General ESG Index. This new index has 15 constituents, slightly more than the 9 that composed the old one. Regrettably, the hypothetical back test provided by S&P DJI only goes as far as June 2021, thus lacking enough historical information to be used in the study. Moreover, a quick overlook into this ESG Index's performance shows that, just as its predecessor, the Index still lags behind its benchmark.

Figure 3. Sharpe, Sortino & Omega ratios – ESG vs. BM

Period	USA	Brazil	Chile	Peru	Colombia	México
2015-2021						
2016						
2017						
2018					*	
2019						
2020						
2021		*				

*Countries present worse risk-adjusted returns in ESG than their BM but better simple returns.

Econometric tests of macroeconomic and market factors behind ESG Index performance

This section aims to examine whether different financial and macroeconomic variables are able to explain the spread between ESG Indexes and BM Indexes performance. **Table 12** shows the independent variables used to obtain first, a general multinomial formula for all geographies and then a specific formula for each region. Given that certain dependent variables are reported in a monthly manner (CPI and Country Risk), the raw data uses end-of-month information for every variable. Before beginning the regression analyses, the Shapiro-Wilks test was used to identify normal distributions in each country's spread. After validating said behavior, an optimal lag was determined for every spread using 4 different lag length selection criteria: Akaike Information Criterion (AIC), Schwarz Criterion (SC), Hannan Quinn Criterion (HQ), and the Final Prediction Error Criterion (FPE). The normal distribution and lag test results can be seen in the **Appendix** section (**A.7** and **A.8)**.

Table 12. Variables Summary

Variables and their descriptions			
VIX	Volatility Index	**CL1**	Crude Oil
DXY	Dollar Index	**HRC1**	Steel
RP	Country Risk	**HO1**	Heating Oil
CPI	Consumer Price Index	**MMX**	Mexican Mixed Crude Oil Price
XW1	Coal Price	**PPT**	Oil Production Colombia
NG1	Natural Gas Price	**CPP**	Copper Production Chile
CO1	Crude Oil, Brent	**CHB**	Chilean Bond Returns

*Country Risk is based on the JP Morgan Emerging Markets Bonds Index (EMBI) for every country

The equation shown below is the general formula used for the multinomial models in every country except USA. This country´s formula includes 3 additional variables known as the Pure Indexes. These indexes provide a clean representation of specific market phenomena that help understand popular market drivers such as Value, Growth, and

Quality. Through a series of multivariate cross-sectional regressions, every pure value index disentangles all factors affecting a portfolio, isolating the desired variable. In this case, the Value, Growth and Quality returns used for the USA model portray the movements in the American market attributed solely to said stock characteristics. Because of a high correlation between the VIX and the Pure Quality Index, this country was tested with 2 different formulas, one including the VIX but disregarding the Quality Pure Index and vice versa.

$$Spread_i = K + \beta_1 Lag + \beta_2 RP + \beta_3 Ln\ CPI + \beta_4 Ln\ VIX + \beta_5 DXY + \beta_6 CO1 + \beta_7 XW1 + \beta_8 NG1 + \beta_9 HO1 + \beta_{10} HRC1 + \beta_{11} Dummy$$

*USA models contain 3 additional variables

After running tests for heteroscedasticity, certain variables where logarithmically transformed in order to obtain better adjusted R^2 results. Additionally, a dummy variable set during the Covid virus outbreak months of March, April, and November 2020 was found to improve results. The variables with their respective transformations, their coefficients, and the standard error reported below each one of them, together with the significance for every regional model are given in **Table 13**.

Table 13. General Model Results[vii]

Dependent variable: Return of ESG – Return of BM Index from every country						
Lags	4	4	10	6	1	1
Variable	Spread USA		Spread Mexico	Spread Brazil	Spread Chile	Spread Colombia
	Model 1	Model 2				
Constant	0.0238	0.0183	-0.0268	-0.1837	0.0106	-22.9345***
	(0.0300)	(0.0304)	(0.0631)	(0.1910)	(0.0114)	(8.3101)
Spread Lag	-0.2306*	-0.1776	-0.2066**	-0.0682	-0.0864	-0.1063
	(0.1191)	(0.1348)	(0.0919)	(0.1005)	(0.1403)	(0.1295)
Country risk	0.0000	0.0000	-0.0009	0.0131	-0.0019	1.4892
	(0.0001)	(0.0001)	(0.0076)	(0.0154)	(0.0015)	(1.0534)
Log Country CPI	-0.0005	-0.0006	0.0111*	-0.0057	0.0008	-2.1089
	(0.0006)	(0.0005)	(0.0065)	(0.0125)	(0.0013)	(1.4193)
Log VIX	0.0007***		0.0003	0.0079***	0.0000	0.0383
	(0.0002)		(0.0008)	(0.0028)	(0.0001)	(0.1366)
Dollar Index	0.0711**	0.0798**	0.1847	0.6038	0.0045	25.2095
	(0.0299)	(0.0306)	(0.1136)	(0.3738)	(0.0163)	(15.8234)
Crude Oil Price	0.003	0.0014	-0.0232	-0.0487	-0.0072**	1.6776
	(0.0042)	(0.0054)	(0.0388)	(0.0385)	(0.0032)	(2.5419)
Coal Price	-0.0024	-0.0042	-0.0305***	-0.0849**	0.001	0.9508
	(0.0045)	(0.0049)	(0.0108)	(0.0398)	(0.0028)	(2.0212)
Natural Gas Price	0.0009	0.0021	0.0126	0.0294	-0.0018	-0.6315
	(0.0028)	(0.0034)	(0.0122)	(0.0218)	(0.0022)	(1.9242)
Heating Oil Price	0.0026	0.0045	0.0379*	0.0639	0.0007	-0.8258
	(0.0078)	(0.0084)	(0.0208)	(0.0456)	(0.0038)	(3.0580)
Steel	-0.006	-0.0049	0.0053	0.0597	0.0022	0.3821
	(0.0042)	(0.0043)	(0.0179)	(0.0456)	(0.0024)	(2.1767)
Dummy	0.0055**	0.0045	0.0029	-0.0267	-0.0019*	-1.8143
	(0.0024)	(0.0027)	(0.0157)	(0.0313)	(0.0010)	(1.8736)
Value	-0.1594*	-0.1395*				
	(0.0801)	(0.0803)				
Growth	-0.296**	-0.248*				
	(0.1302)	(0.1439)				
Log Quality		-0.0007				
		(0.0006)				
Adjusted R^2	*0.2608*	*0.2116*	*0.1183*	*0.1149*	*0.1267*	*0.0315*
Note: Std. Values in parenthesis. Signif codes: *** 1%, ** 5%, * 10%.						

In this general model all regressions present low adjusted R^2 (below 0.4). The first model for the USA contained 6 significant variables while the Mexican, Brazilian, Chilean, and Colombian had 4, 2, 2, and 1, respectively. Moreover, the Stepwise Regression Method[viii] was used in an attempt to construct a more reliable model. Results are shown in **Table 14**, where it is seen that the significant variables and adjusted R^2 values improved for the Mexican, Chilean, and Colombian models, yet still remain very low.

Table 14. General Model Results – Stepwise Method

Dependent variable: Return of ESG – Return of BM Index from every country					
Lag	4	10	6	1	1
Variable	**Spread USA**	**Spread Mexico**	**Spread Brazil**	**Spread Chile**	**Spread Colombia**
Constant	0.0000	-0.0245	0.0103**	0.0112*	-23.4427***
	(0.0005)	(0.0582)	(0.0048)	(0.0067)	(5.7626)
Spread Lag	-0.118	-0.2115**		-0.0729	-0.0904
	(0.1520)	(0.0895)		(0.1452)	(0.1216)
Country risk		-0.0011		-0.0015*	1.6168*
		(0.0071)		(0.0008)	(0.8943)
Log Country CPI		0.0112*			-2.0963*
		(0.0065)			(1.0677)
Log VIX			0.0076***		
			(0.0015)		
Dollar Index	0.0619**	0.1893*	0.4043		25.9014*
	(0.0272)	(0.1118)	(0.2887)		(14.8624)
Crude Oil Price		-0.0216		-0.0062***	2.2044*
		(0.0349)		(0.0015)	(1.2753)
Coal Price		-0.0304***			
		(0.0107)			
Natural Gas Price		0.0125			
		(0.0122)			
Heating Oil Price		0.0364*			
		(0.0186)			
Steel		0.0051		0.0025**	
		(0.0165)		(0.0010)	
Dummy		0.003		-0.0018**	-1.5564
		(0.0145)		(0.0009)	(1.1232)
Value	-0.1437*				
	(0.0729)				
Growth	-0.2075**				
	(0.1037)				
Log Quality					
Adjusted R^2	*0.1267*	*0.1334*	*0.0929*	*0.1682*	*0.0968*
Note: Std. Values in parenthesis. Signif codes: *** 1%, ** 5%, * 10%.					

Lastly, specific models for every Latin-American region were tested following the same steps from the previous base regression and including a Stepwise Regression. The general formulas as well as the models (**Table 15** and **Table 16**) for each region are found below.

$$Spread_{Mexico} = K + \beta_1 Lag + \beta_2 RP + \beta_3 Ln\ CPI + \beta_4 Ln\ VIX + \beta_5 DXY + \beta_6 XW1 + \beta_7 HO1 + \beta_8 HRC1 + \beta_9 CL1 + \beta_{10} MMX + \beta_{11} Dummy$$

$$Spread_{Brazil} = K + \beta_1 Lag + \beta_2 RP + \beta_3 Ln\ CPI + \beta_4 Ln\ VIX + \beta_5 DXY + \beta_6 XW1 + \beta_7 NG1 + \beta_8 HO1 + \beta_9 CL1 + \beta_{10} Dummy$$

$$Spread_{Colombia} K + \beta_1 Lag + \beta_2 RP + \beta_4 Ln\ VIX + \beta_5 DXY + \beta_6 CL1 + \beta_7 PPT + \beta_8 Dummy$$

$$Spread_{Chile} = K + \beta_1 Lag + \beta_2 RP + \beta_4 Ln\ VIX + \beta_5 DXY + \beta_6 XW1 + \beta_7 CPP + \beta_8 CHB + \beta_9 Dummy$$

Table 15. Specific Model Results

Dependent variable: Return of ESG – Return of BM Index from every country				
Lag	10	6	1	1
Variable	**Spread Mexico**	**Spread Brazil**	**Spread Chile**	**Spread Colombia**
Constant	-0.0469	-0.1375	0.0048	-11.029**
	(0.0448)	(0.2155)	(0.0063)	(5.4537)
Spread Lag	-0.2205**	-0.0684	-0.0623	-0.0831
	(0.0855)	(0.0957)	(0.1792)	(0.1306)
Country risk	-0.0003	0.0141	-0.0011	-0.28
	(0.0041)	(0.0165)	(0.0014)	(0.3263)
Log Country CPI	0.0124**	0.0007		
	(0.0054)	(0.0126)		
Log VIX	-0.0001	0.0071***	-0.0002	0.0515
	(0.0007)	(0.0021)	(0.0001)	(0.1097)
Dollar Index	0.1647	0.4501	-0.011	39.1053***
	(0.1043)	(0.2841)	(0.0140)	(14.3485)
Coal Price	-0.0243**	-0.0561	-0.0013	
	(0.0117)	(0.0425)	(0.0014)	
Natural Gas Price		0.0262		
		(0.0255)		
Heating Oil Price	0.0192	0.0785		
	(0.0256)	(0.0929)		
Steel	0.0123			
	(0.0116)			
Crude Oil Price	0.0069	-0.0183		-0.5546
	(0.0291)	(0.0683)		(1.1521)
Mexican Mixed Crude Oil Price	-0.0366**			
	(0.0166)			
Dummy	-0.0004	0.0028		0.3522
	(0.0101)	(0.0143)		(0.5125)
Oil Production Colombia				0.002***
				(0.0001)
Copper production Chile			0.0000	
			(0.0000)	
Chilenian Bonds Return			0.0005	
			(0.0005)	
Adjusted R^2	*0.1203*	*0.0386*	*0.0112*	*0.0265*
Note: Std. Values in parenthesis. Signif codes: *** 1%, ** 5%, * 10%.				

The specific model screening had the lowest adjusted R^2 values of all 4 models for every single country. It can be noted that only the Log VIX variable was significant in the Brazilian regression, while no variable was significant in the Chilean regression. On the other hand, the specific models that resulted from the Stepwise Method in **Table 16** had the highest adjusted R^2 values among the other 3 methods, both for the case of Mexico and Colombia.

Table 16. Specific Model Results – Stepwise Method

Dependent variable: Return of ESG – Return of BM Index from every country				
Lag	10	6	1	1
Variable	**Spread Mexico**	**Spread Brazil**	**Spread Chile**	**Spread Colombia**
Constant	-0.0538	0.0103**	0.0056	-12.9144***
	(0.0434)	(0.0048)	(0.0066)	(0.2333)
Spread Lag	-0.2229***			
	(0.0814)			
Log Country CPI	0.0129**			
	(0.0059)			
Country risk			-0.0011	
			(0.0016)	
Log VIX		0.0076***	-0.0003**	
		(0.0015)	(0.0001)	
Dollar Index	0.1745*	0.4043		36.7736**
	(0.0994)	(0.2887)		(14.0443)
Coal Price	-0.0247**		-0.0015	
	(0.0114)		(0.0014)	
Heating Oil Price	0.0332**			
	(0.0135)			
Steel	0.0123*			
	(0.0073)			
Mexican Mixed Crude Oil Price	-0.0273***			
	(0.0087)			
Oil Production Colombia				0.0361***
				(0.0049)
Copper production Chile			(0.0000)	
			(0.0000)	
Chilenian Bonds Return			0.0005	
			(0.0006)	
Adjusted R^2	*0.1858*	*0.0929*	*0.0307*	*0.1108*
Note: Std. Values in parenthesis. Signif codes: *** 1%, ** 5%, * 10%.				

Furthermore, to avoid the use of individual commodity indexes, 2 additional models were built using the Bloomberg Commodity Index and the Commodity Research Bureau Index to better capture the price movements of a general basket of commodities. These indexes were used separately as they have a high correlation among each other, which would result in multicollinearity problems. **Table 17** and **Table 18** show the regression results for the BCI and CRB, respectively. The use of the BCI Index did not present better adjusted R^2. There were also multiple multicollinearity problems for the Mexican and Chilean models with the use of the CRB Index, thus no results could be provided for the regression tests when substituting individual commodities for said index. However, the highest adjusted R^2 for the USA model and among all regions was obtained with the CRB model while disregarding the VIX variable and including the Quality Pure Index. The value of 0.3223 is, nonetheless, still low for this measurement.

Table 17. General Model Results – BCI Commodity Index

Dependent variable: Return of ESG – Return of BM Index from every country						
Lags	4	4	10	6	1	1
Variable	Spread USA		Spread Mexico	Spread Brazil	Spread Chile	Spread Colombia
	Model 1	Model 2				
Constant	0.0005	-0.0016	-0.0126	-0.0089	-0.0003	-12.8462***
	(0.0030)	(0.0026)	(0.0274)	(0.0396)	(0.0014)	(2.2315)
Spread Lag	-0.1579	-0.0868	-0.2537***	-0.0743	-0.0893	-0.0542
	(0.1671)	(0.1557)	(0.0946)	(0.1076)	(0.1947)	(0.1341)
Country risk	0.0000	0.0000	0.0022	0.0072	-0.0003	0.5481
	(0.0001)	(0.0001)	(0.0084)	(0.0132)	(0.0017)	(0.5885)
Log Country CPI	-0.0004	-0.0005	0.0039	0.0013	0.0003	-1.3321
	(0.0004)	(0.0004)	(0.0046)	(0.0108)	(0.0016)	(0.8575)
Log VIX	0.0006*		-0.0004	0.0071***	-0.0002	0.08
	(0.0003)		(0.0008)	(0.0020)	(0.0002)	(0.1153)
Dollar Index	0.0499	0.0631**	0.1387	0.4226	-0.008	30.4118**
	(0.0318)	(0.0293)	(0.1268)	(0.3177)	(0.0136)	(15.0886)
Value	-0.1546**	-0.1421**				
	(0.0676)	(0.0669)				
Growth	-0.2531**	-0.2127*				
	(0.1216)	(0.1224)				
Dummy	0.002	0.0007	-0.003	-0.007	-0.0009	-0.5616
	(0.0021)	(0.0019)	(0.0078)	(0.0154)	(0.0011)	(0.9666)
Log Quality		-0.0011*				
		(0.0006)				
Bloomberg Commodity Index	0.0033	0.0213	0.0755	0.0478	0.006	-5.9329
	(0.0231)	(0.0196)	(0.0605)	(0.1224)	(0.0085)	(7.3174)
Adjusted R^2	0.1026	0.1046	0.0204	0.0280	0.0292	0.0394
Note: Std. Values in parenthesis. Signif codes: *** 1%, ** 5%, * 10%.						

Table 18. General Model Results – CRB Commodity Index

Dependent variable: Return of ESG – Return of BM Index from every country						
Lags	4	4	10	6	1	1
Variable	Spread USA		Spread Mexico	Spread Brazil	Spread Chile	Spread Colombia
	Model 1	Model 2				
Constant	0.0012	-0.0022	-0.0270	-0.0065	-0.0002	-12.8741***
	(0.0041)	(0.0020)		(0.0401)		(2.2191)
Spread Lag	-0.1368	-0.0703	-0.1938	-0.0732	-0.0690	-0.0674
	(0.1854)	(0.1676)		(0.1043)		(0.1294)
Country risk	0.0000	-0.0001	0.0073	0.0056	-0.0004	0.5146
	(0.0001)	(0.0001)		(0.0131)		(0.6168)
Log Country CPI	-0.0005	-0.0007**	0.0060	0.0022	0.0002	-1.4009
	(0.0005)	(0.0003)		(0.0105)		(0.8630)
Log VIX	0.0007***		0.0003	0.0065***	-0.0002	0.0501
	(0.0003)			(0.0022)		(0.1191)
Dollar Index	0.0659**	0.0748***	0.2409	0.3654	-0.0113	30.8703**
	(0.0269)	(0.0240)		(0.3025)		(14.4479)
Value	-0.1409	-0.1029*				
	(0.0926)	(0.0615)				
Growth	-0.2579**	-0.2038**				
	(0.1082)	(0.0998)				
Dummy	0.0016	0.0004	-0.0091	-0.0037	-0.0008	-0.4653
	(0.0029)	(0.0016)		(0.0148)		(0.9645)
Log Quality		-0.0016**				
		(0.0006)				
CRB Commodity	0.0512	0.0741**	0.0923	-0.1036	0.0029	-14.3976*
	(0.0703)	(0.0348)		(0.2024)		(8.2820)
Adjusted R^2	0.2352	0.3223		0.0284		0.0588
Note: Std. Values in parenthesis. Signif codes: *** 1%, ** 5%, * 10%.						

Overall, the first general regression for Brazil obtained the best adjusted R^2 for the region where only two variables, the VIX and Coal Price, had great significance. As mentioned before, Mexico and Colombia had the highest adjusted R^2 in the specific stepwise models with 0.1858 and 0.1108, respectively. There were 7 significant variables in the Mexican model: the lagged spread itself, the country's CPI (inflation), the Dollar Index, Coal Price, Heating Oil Price, Steel Price, and the Mexican Mixed Crude Oil Price. Contrarily, Colombia had 3 significant variables, them being the constant, the Dollar Index, and the Oil Production in the country. The American model that excludes the VIX and includes the Quality Pure Index with the CRB Commodity Index produced a 0.3223 adjusted R^2. In said model, 6 variables were significant: the country's CPI, the Dollar Index, the Growth Pure Index, the Value Pure Index, the Quality Pure Index, and the CRB Commodity Index. Despite

the several tests runs with different methods, none of the best models have acceptable adjusted R^2 so as to conclude that the explanation was complete.

As a general wrap up of the econometric tests carried out in this section, we find that there is very scant explanation power in macroeconomic variables (or for the case of the USA, market factors such as Value or Quality) that are able to secure an account for the variability observed in the ESG Indexes spread over their BM. Nevertheless, as shown above, volatility is a factor that consistently weights in the USA and Brazil and less so in Chile. Energy prices have a steady influence in the region, especially in Mexico´s ESG spread and inflation is found to affect the US, Mexico and Colombia´s spreads also along with the dollar index in precisely these three countries (which by the way are the same trio that outperform the rest of countries in terms of returns). The CRB Index offers also explanation for the Colombian and American ESG spreads. Country Risk work for Colombia and Chile and finally steel works relatively well for Mexico and Chile.

The case of USA is special because there are market factor indexes for that country that no other country has produced and, in these runs, all the factors tested work well to explain the variability in the ESG spread, namely Value, Growth and Quality, reflecting perhaps that some bets on those factors explain the difference in returns according to their relative presence in the Index constituents.

Portfolio Diversification though ESG Indexes

The most popular risk management strategy in business is known as diversification. Maintaining a well-balanced mixture of different types of assets helps limit exposure to risk. In that sense, the risk of the portfolio as a whole is lowered as individual securities are averaged down with the rest of the holdings, increasing the probability of yielding higher long-term returns. Bearing this explanation in mind, does ESG possess a greater inherent risk than its benchmarks? A straightforward answer can be interpreted from renowned economist and Nobel Prize winner, Harry Markowitz's Modern Portfolio Theory. His thesis revolves around risk-averse investments for different levels of expected returns, which can be manipulated through portfolio diversification. According to Markowitz's argument, the fact that ESG Indexes are constructed from other conventional indexes makes them impossible to be more diversified than their source (Markowitz, 1952). This is because certain assets are being disregarded during the screening, thus diminishing asset distribution, and producing more volatility. In simple words, increased risk through loss of diversification. This interpretation of the Modern Portfolio Theory was first discussed by Andrew Rudd in his paper "Social Responsibility and Portfolio Performance" (Rudd, 1981), and had been unquestioned by several authors (e.g., Bauer et al., 2006; Barnett & Salomon, 2006; Renneboog, ter Horst & Zhang, 2008) for nearly three decades up until Hoepner in 2010.

Financial Data Scientist, Andreas G.F. Hoepner refuted Rudd's conclusion in "Portfolio diversification and environmental, social or governance criteria: Must responsible

investments really be poorly diversified?". His proposed model identifies three drivers of portfolio diversification influenced by ESG criteria: number of stocks, correlation among stocks, and average specific risk of stocks. The abovementioned approach suggests that even though ESG screenings diminish portfolio diversification by reducing the number of stocks, and including higher correlated stocks, it equivalently improves it by reducing the average volatility of the portfolio through wise inclusions. In simplistic metaphorical terms, putting the eggs in different baskets should also consider the quality of the baskets. This is because according to Hoepner, a firm's ESG rating has a statistically significant negative relationship with a company's specific risk.

Similarly, empirical evidence proposed by Bello (2005) finds that there is no significant difference in the portfolio diversification of conventional vs responsible funds in the US. Likewise, a 2007 study argues that Socially Responsible Investments (SRI) present comparable standard deviations with conventional investments (Schröder, 2007). Bello's and Schröder's findings support Hoepner's statement that ESG criteria does not necessarily improve diversification, but it merely creates a proportional effect on the portfolio's standard deviation. This evidence is consistent with our findings of the standard deviations of ESG, and Benchmark Indexes as shown in **Table 19**. In half the cases ESG's volatility is greater, and lower in the other half. However, these differences are marginal, and can be deemed comparable.

Table 19. ESG vs BM, Standard Deviations - Sept 2015- December 2021

Country	ESG	BM	Difference (ESG-BM)*
Brazil	24.65%	26.82%	-0.022
Chile	20.16%	20.44%	-0.003
Peru	18.80%	17.56%	0.012
Colombia	18.52%	18.76%	-0.002
USA	18.30%	18.23%	0.001
Mexico	16.46%	15.96%	0.005

*A green color means that the ESG Index has less volatility than its BM

Similarly, results are mixed from a Beta point of view as seen on **Table 20**. This data was obtained with the Bloomberg CORR function. Organically, the Beta's of each Benchmark Index is 1 as they represent the overall investment universe in their respective capital markets and carry their systematic risk. Mexico's and USA's Betas are vaguely lower than the market risk, while Brazil's is clearly lower. Contrarily, Colombia's Beta is slightly higher than its benchmark, while Chile's is evidently higher. This indicates that there is no clear improvement or deterioration of diversification when applying an ESG screening.

Table 20. ESG vs. BM, Betas – Sept 2015 – December 2021

Country	Beta*	
	ESG	BM
USA	0.99	1.0
Brazil	0.81	1.0
Colombia	1.01	1.0
Mexico	0.98	1.0
Chile	1.06	1.0
Peru	0.84	1.0

*A green color means that the ESG Index has a lower Beta than its BM

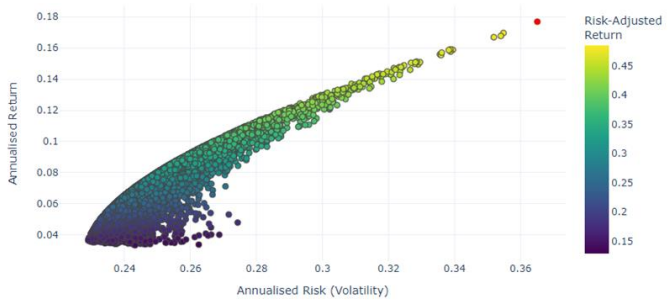
A more technical approach was taken to further analyze the effects of ESG Indexes in portfolio diversification for Latin American capital markets. The Mexican, Chilean, Brazilian, and Colombian ESG & BM Indexes were divided into different portfolios and examined through a Markowitz optimization model. These indexes were transformed into a common currency, the US Dollar, and common market trading days in order to be properly compared. Given that the historical Peruvian ESG Index analyzed during this study has been discontinued, the lack of information didn't allow for its transformation into USD and was thus disregarded for the following tests. **Figure 4(a)** shows a baseline model comprised of the four Latin American Benchmark Indexes.

The other four resulting models represent the original Benchmarks and add every individual ESG Index in each instance, making a total of five Markowitz models including the BM baseline. **Table 21** shows a summary of the optimal portfolio's risk-adjusted return (annualized return / annualized volatility) within each model. The addition of an ESG Index to the baseline model of Benchmarks worsen the maximum risk-adjusted return in every case except for the inclusion of the Mexican ESG.

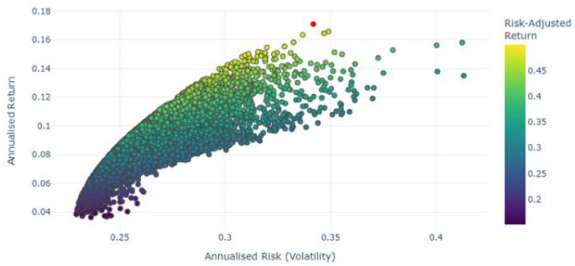
Table 21. Optimal Portfolio Risk-Adjusted Returns for BM Markowitz models (ref. **Figure 4 (next page)**)

Portfolio	Risk-Adjusted Return
4 BM	48.45%
4 BM + Mexico ESG	49.98%
4 BM + Brazil ESG	46.74%
4 BM + Colombia ESG	46.46%
4 BM + Chile ESG	46.00%

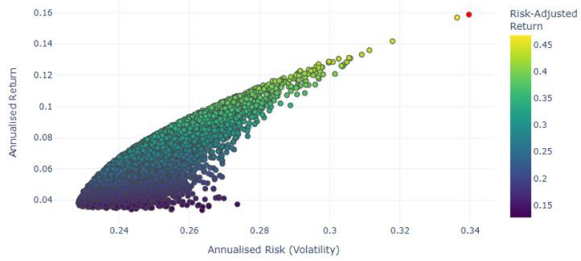
Figure 4. Markowitz Models: Benchmark Baseline + ESG Indexes



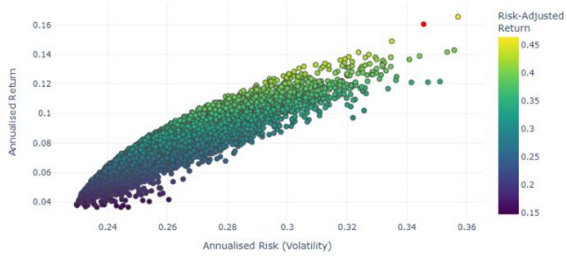
(a) 4 Benchmarks



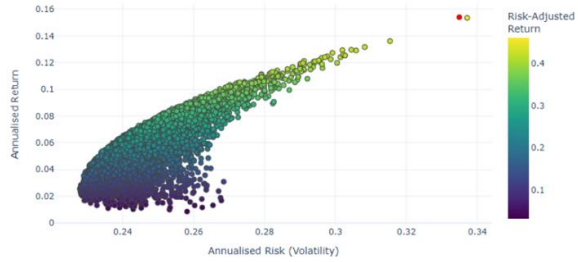
(b) 4 BM + ESG Mexico



(c) 4 BM + ESG Colombia



(d) 4 BM + ESG Brazil



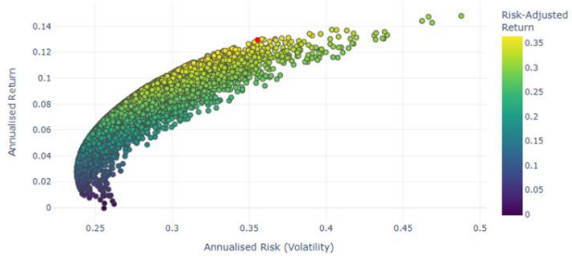
(e) 4 BM + ESG Chile

Inversely, the same tests were performed using a baseline model comprised of the four ESG Indexes and then adding each individual BM Index in every instance (total of five models including the ESG baseline), as seen in **Figure 5**. The summary of the figure presented in **Table 22** indicates that the risk-adjusted return of the baseline ESG model is improved on every occasion with the inclusion of a BM Index.

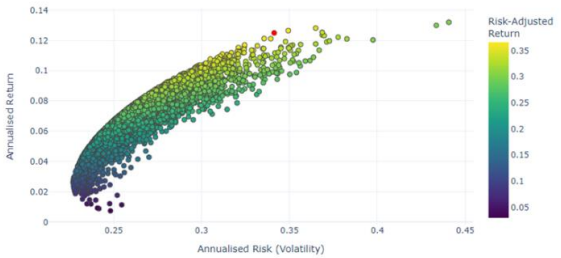
Table 22. Optimal Portfolio Risk-Adjusted Returns for ESG Markowitz Models (ref. **Figure 5 next page**)

Portfolio	Risk-Adjusted Return
4 ESG	36.42%
4 ESG + Brazil BM	50.96%
4 ESG + Chile BM	36.69%
4 ESG + Mexico BM	36.61%
4 ESG + Colombia BM	36.60%

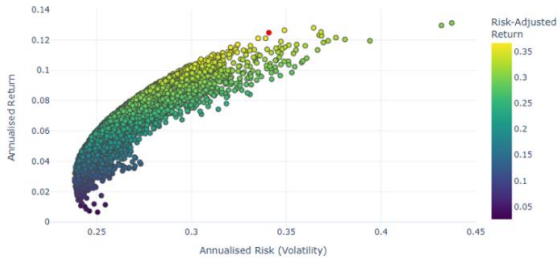
Figure 5. Markowitz Models: ESG Baseline + BM Indexes



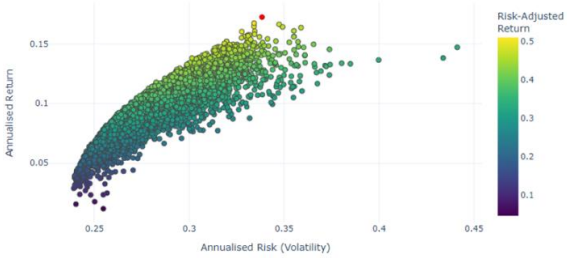
(a) 4 ESG



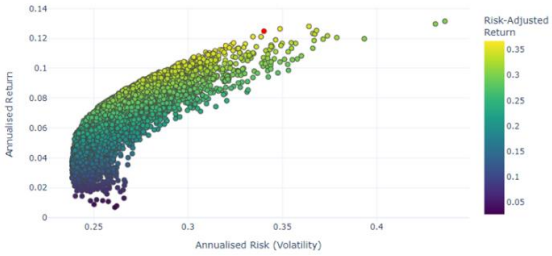
(b) 4 ESG + BM Mexico



(c) 4 ESG + BM Colombia



(d) 4 ESG + BM Brazil



(e) 4 ESG + BM Chile

The effects of loss-gain of diversification in ESG suggested by Hoepner are not seen during the tests. Nonetheless, these results are in line with the basic interpretation of the effect of Markowitz's Modern Portfolio Theory in ESG: given that ESG Indexes come from other Conventional Indexes, it is impossible for the former to be more diversified than the latter. For the case of Latin American Indexes, the inclusion of ESG Indexes does not improve the diversification of a Benchmark portfolio, just as the inclusion of BM Indexes does improve the diversification of an ESG portfolio.

Portfolio Diversification: The Case of Brazil

As mentioned before, the available information resources for this paper were able to provide the composition for the Brazil ESG Index (ISE) only. Because of this, two specific Markowitz models were built to compare possible portfolio structures between ESG and BM Indexes in Brazil. The companies belonging to the Brazilian Market Benchmark (Bovespa) were filtered in order to isolate the ones that only belong to the BM from the ones that also compose the ESG Index.

This resulted in two company lists for the Brazil analysis: the Bovespa ex. ESG, making up a list of purely Benchmark companies, and the ISE Index, with exclusively ESG companies. **Figure 6** and **Figure 7** show the Markowitz models for the built portfolios using the BM ex. ESG and ESG lists respectively.

Four features can be observed from the images:

1. The BM Model has greater annualized return thresholds
2. slightly greater volatility thresholds
3. greater Sharpe Ratio thresholds
4. the risk adjusted return of the optimal portfolio is better (1.54% vs. 1.21%).

This evidence is in line with the behavior seen for Brazil in **Figure 1**, where the BM has significantly higher normalized returns than the ESG Index. Therefore, there is a loss of diversification in the Brazilian ESG screening.

Figure 6. Markowitz Model: Brazil BM ex. ESG

Figure 7. Markowitz Model: Brazil ESG

Furthermore, there is enough data in the case of Brazil (this information is not available for the rest of the LATAM countries relevant to this study) to conduct a descriptive analysis of the size effect inside the ESG Index for that country. It can also be seen on the **Table 23**, that its ESG Index (the ISE Index) is very well diversified when divided by size deciles in market capitalization having a mostly regular sample of companies in each one, so as not to be characterized as "only small" or "only large" companies inside their ESG portfolio and thus implying a balanced company size among the ESG's constituents. On the other hand, when analyzing sector weightings on both of the benchmarks, two of the largest Brazilian companies (Petroleo Brasileiro with 11.4 and Vale with 14.68%), which are not constituents on the ISE index, are driving the IBOVESPA's performance and achieving greater returns versus the ISE Index (**Table 24**). This leads to the conclusion that the size and weight of these companies in the benchmark index, as well as their outstanding returns do play a role in the outperformance over the ESG Index.

Table 23. Acceptable diversification in Brazil's ESG Index by size deciles

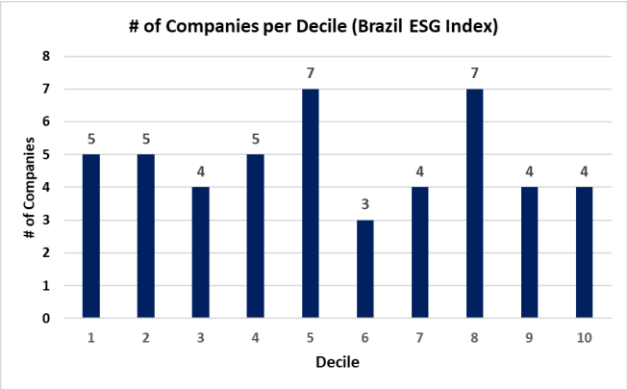
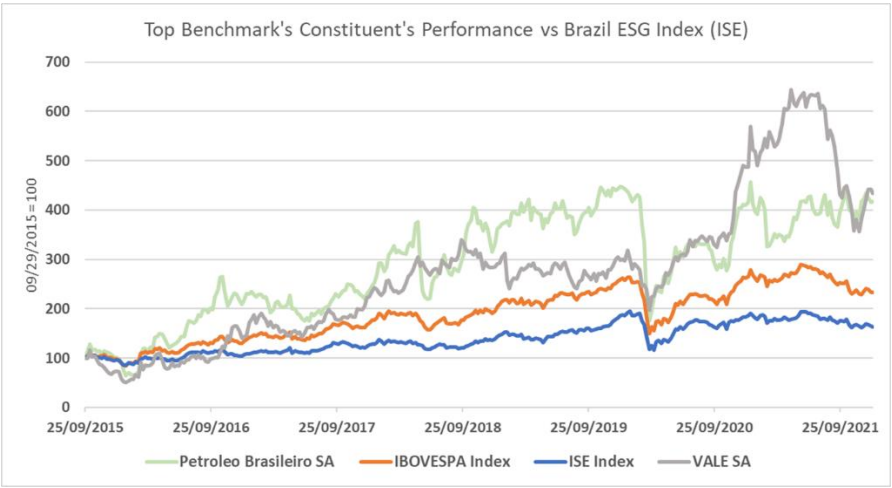


Table 24. Two important companies in Brazil's Benchmark carry the low of difference vs the ESG index



Conclusions

Since the introduction of ESG-guided investing in the 1960s, socially responsible factors have been gaining traction and enticing investors to incorporate non-financial reporting within their investment methodologies. Its current exponential growth in interest has been driven by the urge to act for the greater good and address general problems such as social inequality, climate change, sustainability concerns, and promote overall entrepreneurial core values. As ESG Indexes by country have emerged in recent years, their performance can be compared to that of their national benchmark indexes and evaluate its effectiveness.

The information provided by the S&P Dow Jones Indexes (developer of the most representative ESG Indexes per country) has helped us analyze these instruments for key markets in Latin-America for the period of September 28, 2015, to December 31, 2021. Throughout this study we manage to respond the following research questions: (i) Can ESG Indexes outperform their Market Benchmarks? (ii) Historically, have ESG Indexes attained better risk-adjusted returns than the market? (iii) Is there a greater inherent risk in ESG Indexes than their Benchmarks? (iv) Does ESG investing work in Latin-American markets (Brazil, Mexico, Chile, Peru, Colombia) for diversification purposes? And, (v) What investment or macro factors lay beneath this behavior for each index?

The study finds that ESG criteria has indeed echo in markets, but the results are mixed for Latin countries. In terms of description parameters, in half the cases ESG country indexes' volatility is greater that their own country benchmarks (BMs) however, these differences are marginal, and it can be said that they are comparable in the period under study (2015-2021).

This first overview shows that there are split results in volatility and simple returns when comparing ESG and BM Indexes in the selected geographies. All correlations between ESG and BM are very strong and positive. ESG indexes in Brazil and Chile have less volatility than their BMs and lower returns over the period, contrary to ESG in USA and Mexico which have higher volatilities and greater returns than their BMs. Colombia has less volatility than its benchmark but higher returns, while the exact opposite is shown in Peru with higher volatility and lower returns.

The data shows that the American, Colombian, and Mexican ESG indexes outperform their BM´s in this period, while the Peruvian, Brazilian, and Chilean lag behind them[ix]. This happens using three efficiency ratios (Sharpe, Sortino and Omega) both in spread form and also using ratios of them, meaning that they (1) receive better excess return per unit of overall volatility, (2) receive better excess return per unit of downside volatility, and (3) are less likely to experience negative returns than their BMs. It can also be observed that even though Peru and Brazil have greater efficiency ratios than Mexico and Colombia, they do not manage to outperform their Benchmarks.

Clearly, from a risk-adjusted return and simple return point of view, the USA's, Colombia's, and Mexico's ESG indexes outperform their counterparts in almost every occasion. Conversely, the benchmark indexes in Brazil, Chile, and Peru beat ESG most of the time. It can also be noted that USA's ESG Index undoubtedly distinguishes itself from the

LATAM indexes, achieving significantly higher efficiency ratios and a triple digit growth over the data period.

Above all this, the study finds that ESG criteria does not necessarily improve diversification, but it merely creates a proportional effect on the portfolio's standard deviation. This indicates that there is no clear improvement or deterioration of diversification when applying an ESG screening in LATAM countries. Also, the study finds no clear indication of a size effect (i.e., that ESG Indexes performance is due to the size of its constituents) either in the US or Brazilian markets (the only two markets that lend themselves with the data to test this effect). We do find though that a momentum and quality effect might be in play in the US ESG Index.

Trying to find some economic and financial sense of the econometric tests carried out in the corresponding section above, we find that although there is scarce explanation power in macroeconomic variables (or for the case of the USA, market factors such as Value or Quality) to secure a solid account for the variability observed in the ESG Indexes spread over their BM, we can indeed sketch out a rough postulation of the share that does arrive at the objective. If inflation and the dollar index were behind the trio of countries with the best performance, it could mean that stocks with the ESG label have better pricing power that the rest. In the same tenor, if energy and commodity prices in general have a strong influence in the explanation of ESG spreads during the test period, it could reflect the upside that the commodity cycle has had on certain stocks with high and positive exposure to it and that implicitly at least, ESG Indexes contains more of these stocks that the corresponding country index. In any case, we find that some form of the "habitat hypothesis" might be at play behind this phenomenon, meaning that there are stocks inside the ESG Index composition with exposure to certain success factors that are able to account for the winning performance and, if this were the case, that we should expect a cyclical behavior in ESG spreads, as these success factors enter and exit from market vogue.

Finally, further research shall clarify the factor and diversification issues once is possible to test these influences with the constituent list of each index and beyond that, allow for enough market cycles to find if ESG adds true value to a portfolio when volatility rises significantly, as is typical of those episodes.

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Appendix

A1. Sharpe Ratio Formula

$$S = \frac{R - R_f}{\sigma}$$

A2. Sortino Ratio Formula

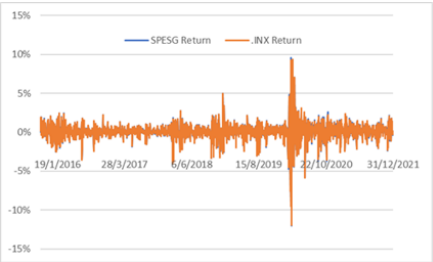
$$S = \frac{R - R_f}{\sigma_d}$$

A3. Omega Ratio Formulas

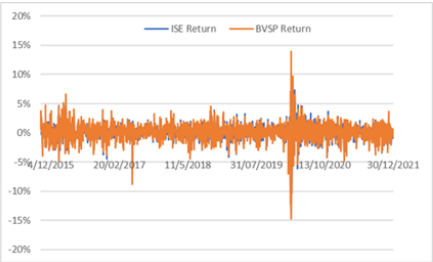
$$\Omega = \frac{\Sigma\, Adjusted\ Returns > 0}{/\Sigma Adjusted\ Returns < 0/}$$

$$\Omega = \frac{P(R - MAR)}{/N(R - MAR)/}$$

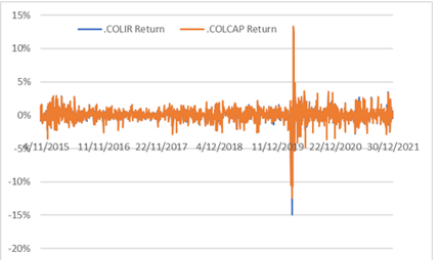
A4. ESG and BM Returns



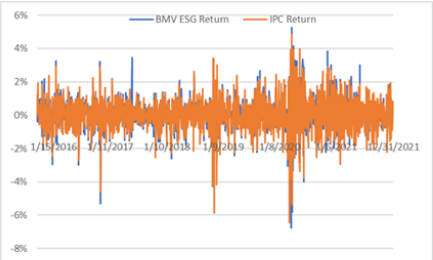
USA



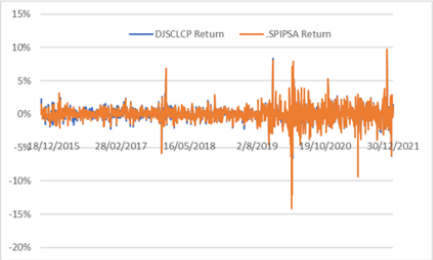
Brazil



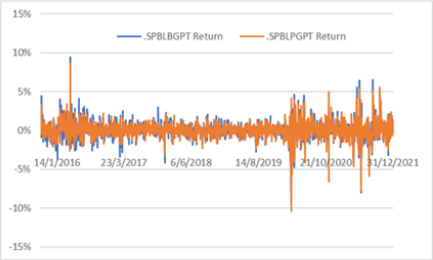
Colombia



Mexico

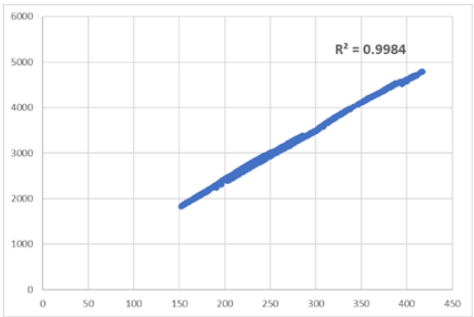


Chile

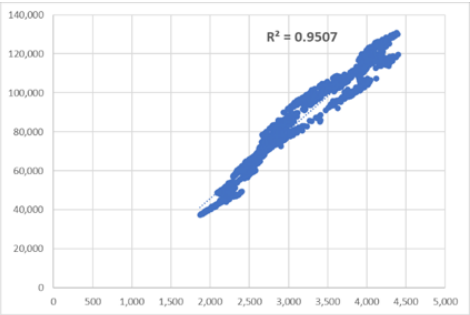


Peru

A5. ESG and BM Correlations



USA



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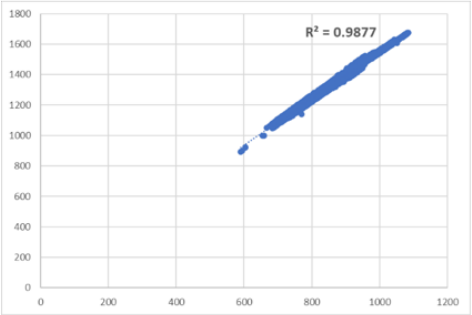

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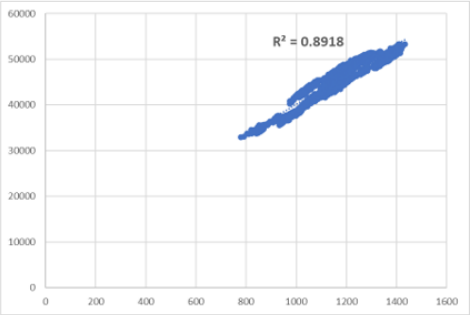

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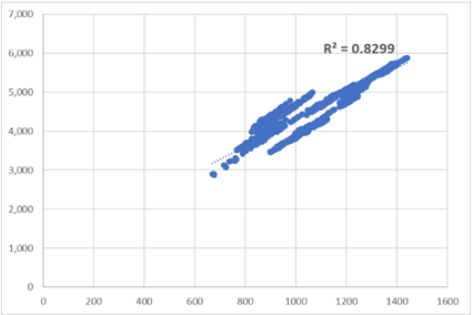
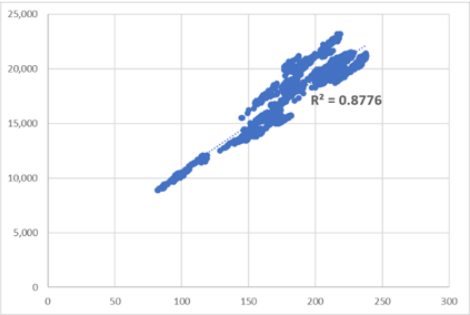


Chile



Peru

A6. Rolling Returns by ESG Index

		Rolling Window								
		90 (Sample Size)			180 (Sample Size)			360 (Sample Size)		
Ticker	**ESG Index**	**Spread > 0**	**n**	**Ratio**	**Spread > 0**	**n**	**Ratio**	**Spread > 0**	**n**	**Ratio**
SPESG	S&P 500 ESG Index, USA	948	1,488	63.71%	1,112	1,398	79.54%	814	1,218	66.83%
ISE	Corporate Sustainability Index (ISE)	557	1,457	38.23%	371	1,367	27.14%	315	1,187	26.54%
DJSCLCP	Dow Jones Sustainability Chile Index	256	1,468	17.44%	136	1,378	9.87%	0	1,198	0.00%
SPBLBGPT	Good Corporate Index (IBGC)	609	1,484	41.04%	528	1,394	37.88%	576	1,214	47.45%
COLIR	IR Recognition Index (COLIR)	910	1,436	63.00%	1,046	1,346	77.00%	1040	1,166	89.19%
BMV ESG	S&P/BMV Total Mexico ESG Index	910	1,486	61.00%	928	1,396	66.48%	917	1,216	75.41%

A7. Shapiro-Wilks test for Normality

Spread	Shapiro Wilkins Statistic	P-value	Distribution
USA	0.9847	0.5047	Normal
Brazil	0.9915	0.9026	Normal
Mexico	0.9726	0.1034	Normal
Chila (Levels)	0.9893	0.7864	Normal
Chile (Log)	0.9761	0.1677	Normal
Colombia (Levels)	0.8814	0.0000	Not Normal
Colombia (Log)	0.9666	0.0452	Not Normal
Colombia (Log of squared values)	0.9835	0.4404	Normal

A8. Optimal Lag Tests

USA

Criteria	Optimal lag	Lags									
		1	2	3	4	5	6	7	8	9	10
AIC(n)	4	-10.9015	-11.0804	**-11.0962**	-11.1011	-11.0706	-11.0873	-11.0612	-11.0324	-11.0444	-11.0253
HQ(n)	3	-10.8751	-11.0408	-11.0434	-11.0351	-10.9915	-10.9949	-10.9556	-10.9136	-10.9124	-10.8802
SC(n)	2	-10.8346	-10.9800	-10.9624	-10.9339	-10.8699	-10.8531	-10.7936	-10.7313	-10.7098	-10.6574
FPE(n)	4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Mexico

Criteria	Optimal lag	Lags									
		1	2	3	4	5	6	7	8	9	10
AIC(n)	10	-9.0329	-9.1295	-9.2688	-9.2883	-9.2619	-9.2742	-9.2636	-9.2741	-9.3726	**-9.4471**
HQ(n)	10	-9.0065	-9.0899	-9.2160	-9.2223	-9.1827	-9.1818	-9.1580	-9.1553	-9.2406	-9.3019
SC(n)	3	-8.9660	-9.0291	-9.1349	-9.1210	-9.0612	-9.0401	-8.9960	-8.9730	-9.0381	-9.0791
FPE(n)	10	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Brazil

Criteria	Optimal lag	Lags									
		1	2	3	4	5	6	7	8	9	10
AIC(n)	6	-7.0117	-7.0669	-7.0455	-7.1294	-7.1546	**-7.1977**	-7.1790	-7.1536	-7.1267	-7.0987
HQ(n)	6	-6.9853	-7.0273	-6.9927	-7.0634	-7.0754	-7.1053	-7.0734	-7.0348	-6.9947	-6.9535
SC(n)	2	-6.9448	-6.9665	-6.9117	-6.9621	-6.9539	-6.9635	-6.9114	-6.8525	-6.7922	-6.7307
FPE(n)	6	0.0009	0.0009	0.0009	0.0008	0.0008	0.0007	0.0008	0.0008	0.0008	0.0008

Chile

Criteria	Optimal lag	Lags									
		1	2	3	4	5	6	7	8	9	10
AIC(n)	1	**-12.5667**	-12.5387	-12.5079	-12.5345	-12.5069	-12.4949	-12.4920	-12.4614	-12.4322	-12.4095
HQ(n)	1	-12.5403	-12.4991	-12.4551	-12.4685	-12.4277	-12.4025	-12.3864	-12.3426	-12.3002	-12.2643
SC(n)	1	-12.4998	-12.4383	-12.3741	-12.3672	-12.3061	-12.2607	-12.2244	-12.1603	-12.0977	-12.0415
FPE(n)	1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Colombia

Criteria	Optimal lag	Lags									
		1	2	3	4	5	6	7	8	9	10
AIC(n)	1	**1.5133**	1.5376	1.5461	1.5379	1.5624	1.5896	1.6003	1.6279	1.6248	1.6374
HQ(n)	1	1.5397	1.5772	1.5989	1.6039	1.6416	1.6820	1.7059	1.7467	1.7568	1.7826
SC(n)	1	1.5802	1.6379	1.6799	1.7052	1.7631	1.8238	1.8679	1.9290	1.9593	2.0054
FPE(n)	1	4.5420	4.6537	4.6941	4.6562	4.7726	4.9059	4.9609	5.1025	5.0899	5.1588

Endnotes

[i] Stands for Compounded Annual Growth Rates.
[ii] Stands for Key Performance Indicators.
[iii] It should be also mentioned that other ESG Index providers were taken into consideration, such as the MSCI Indexes -which by the way present the same regions as the S&P´s-, however, the S&P Indexes showed better performance in our preliminary screenings, specifically in terms of the consistency of returns.
[iv] Nobel Prize winner, William F. Sharpe (1966) first developed the Sharpe Ratio in 1966 to measure the reward-to-variability of investing in a specific security or a portfolio by adjusting for its inherent volatility with a risk-free asset. It represents the excess return received per unit of additional risk. Although it was initially intended for mutual funds, the Sharpe Ratio is currently one of the most popular measurements for risk-adjusted return in finance.
[v] Recently introduced in 2002 by Con Keating and William Shadwick in the article "A Universal Performance Measure". Although it's based on the same principles of the Sharpe Ratio, the Omega Ratio does not assume normal distributions in asset returns. This means that kurtosis (the degree of score clusters in the tails of a distribution) and skewness (the asymmetry that deviates from a normal distribution) are considered in the calculations, thus producing a much more accurate result. The Omega Ratio uses a minimum acceptable risk (MAR) to obtain the cumulative excess returns, which in this case were the risk-free rates used in the Sharpe and Sortino Ratios.
[vi] Unfortunately, information regarding the specific composition of most ESG indexes that were tested was not available at the time of this study, but for the cases of Brazil and the USA.
[vii] In all econometric tables std. values refers to the standard error of the coefficient or standard deviation around the mean result, say, the beta itself. Also, in all econometric tables in this study a p-value referenced with one, two or three asterisks (*) is interpreted in the following way: The probability that the test hypothesis is false and that indeed an effect was observed -when it is below the cut, that is < 0.5 for example-.
[viii] This method comes from a machine learning technique in which the software runs both top-down (all variables included and then discarding worst models) and bottom-up (no variables included and adding according to best incremental performance) econometric runs and arrives at the best performing model.
[ix] As was mentioned in the footnote on page 1, we manage to extend the analysis into the 31st of December 2022 an even though the results are generally consistent with the findings presented in the conclusion section, we did find that in the period from September 2015 until December 2022 Colombia´s ESG Index no longer beats its benchmark nor it does on every other measurement when tested in that year alone (2022); nevertheless, both the US ESG Index and Mexico´s own index do.