Final Report:

Is a Firms ESG Score Priced?

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Abstract

As investors and corporations alike have begun placing more emphasis on ESG performance, a natural question to consider is how these factors relate to stock performance. This paper investigates the correlation between ESG and abnormal stock returns. We examine the effects of ESG as a whole as well the individual impact of the environmental, governance, and social factors. We also considered these effects in the context of different industries. We sampled data from the Russell 3000 between July 2010 and July 2020, which was used in a modified Farma French model to conduct a series of ordinary least squares (OLS) regressions. Our results indicate that ESG does have a statistically significant positive correlation with abnormal returns. As individual factors, governance and environmental had positive correlations with abnormal returns, while social was negatively correlated. The energy, financials, materials, real estate, and utilities sectors appear to be influenced differently than the rest of the sectors, with returns being more negatively impacted by higher social ratings. Interestingly, after considering the interactive dummy variable, the returns of the energy and materials sectors are positively correlated with the social factor.

Introduction:

Our research attempts to answer the question: Should investors expect increased returns to compensate them for investing in ESG friendly firms? At the time of this research paper, ESG investments have been trending in popularity due to investors becoming increasingly aware of ethical issues, and that high ESG rated companies are thought to be related to more ethical activities (Collins & Sullivan, 2020). ESG stands for Environment, Social, and Governance, which covers the three main areas where criticism is made on firms in ethical matters. For example, in a paper concerning ethics and ESG, Armstrong (2020) makes a note of a royal commissioner's

scathing recent report on the finance industry's lack of integrity, honesty, and ethics. The commissioner went on to endorse increased reporting of non-financial indicators of performance. Firms are under a significant amount of scrutiny as investors demand improvements in corporate citizenship while the younger generations are demanding more responsibility by these large corporations as they are trying to look out for their futures and next generations (RBC Wealth Management, 2020). Many issues have been brought up, but many individuals' widespread complaints have been about the lack of responsibility for the environment and how companies treat their employees and communities. Even amid the ongoing pandemic, one RBC client was adamant that their entire portfolio needed to have a positive ESG stance, which was prompted by their young daughter's concern for the environment. These situations are becoming far more commonplace (RBC Wealth Management, 2020). Investors are also demanding better corporate governance as concerns about CEO ethics increase due to evidence of CEOs abusing their powers to put their needs over the shareholders (Eccles & Klimenko, 2019). A particularly dramatic example of this shift occurred in the banking industry following the sub-prime mortgage crisis and credit crunch. Investors began demanding management take a more long-term view of their interests, respond to their obligations to society, and implement more effective management and control (Jizi et al., 2014). This concern still falls under an ESG factor (governance), which suggests that the degree of ESG activities taken by corporate citizens affects everyone.

However, Is the pursuit of a more sustainable entity a factor in driving abnormal returns given the modern environment of increased investor demand for sustainable investment opportunities? If so, can a potential ESG premium be exploited? Are specific ESG factors more related to these returns than others? Are these relationships consistent across industries? The current literature fails to answer all of these questions definitively. Much of the existing literature

on the relationship between ESG and stock returns has come to conflicting conclusions, making it difficult to reach a decisive conclusion. Furthermore, there are no studies we are aware of that cover our date range (2010-2020) while considering not only if ESG is correlated with increased abnormal returns, but how each factor individually contributes, as well as the industry-specific relationships. We aim to conclusively answer these questions in the context of the modern investing environment, providing critical information not only to investors looking to receive excess returns but firms seeking to maximize shareholder wealth. Providing evidence of these relationships could conceivably encourage more investors to choose sustainable investments, as well as push firms to improve their ESG performance. In the case where a high ESG rating does lead to greater returns, investors and managers need to know because, for either group, it leads to greater wealth. This research is essential, as it can add incentives for companies to be more ethical if they know that ethical actions could indirectly lead to greater wealth. This would be beneficial not just for the shareholders but for all stakeholders as well. We will attempt to solve our question: if corporate citizens are ethical, can it make them wealthier? We do this by looking at the relationship between ESG and returns. The research that we conduct will test if ESG ratings are effectively priced in the market by analyzing firms with high and low ESG scores.

Further content of this paper on ESG stocks returns will start with a summary of some research already conducted on ESG, which will provide some background on the subject. This will allow us to understand the research methodology and data used, as well as the strengths and weaknesses of current research. Next, we will talk in-depth about our research and our statistical hypotheses used in the testing. This research will test the hypothesis:

1) ESG ratings are effectively priced within the market

We will also test the sub hypotheses:

H0(a): Environmental factor is priced higher within the ESG model.

H0(b): Social factor is priced higher within the ESG model.

H0(c): Governance factor is priced higher within the ESG model.

H1: All factors are optimally priced within the ESG model.

We will then cover what data we used as well as more in-depth coverage of the modified Frama-French factor methodology used in the testing. This will be followed by the analysis of our results. We will then discuss the limitations of our research as well as considerations for further investigation. Finally, we will end with the conclusions we have reached.

Literature Review:

Extensive research has been conducted on the relationship between ESG factors and performance. The existing literature can be broadly categorized into firm returns, factor analysis research, risk/return profiles, disclosures, and investor sentiment. This review will examine the complicated, and in some cases conflicting, prior research that we will build on.

Firm/Stock Returns

If higher ESG ratings lead to increased firm returns, this improved performance would be reflected in the firm's stock price. Peiris and Evans (2010) investigated the relationship between ESG factors and the performance of US-listed companies by evaluating their impact on returns, valuations, and operational performance. Peiris and Evans (2010) found that there is a clear positive relationship between ESG scores and operating performance. Higher ESG rated firms also have higher earnings multiples. Similarly, Zhao et al. (2018) examine the relationship between ESG score and financial performance, although their research specifically covers the Chinese

energy markets. The study showed a significant positive relationship between financial performance and ESG scores. Friede et al. (2015) also consider ESG's influence on financial performance by studying aggregated empirical evidence from over 2000 studies. The authors find considerable evidence supporting the case of ESG as a practical option for investment managers and suggest that a shift towards long term responsible investing is important in fulfilling fiduciary responsibility to clients and their portfolios. These findings are supported by Giese et al. (2019), who explore how ESG can affect both company valuation and performance. They investigate three transmission channels within a discounted cash flow: cash-flow, idiosyncratic risk, and the valuation channel. Through analysis of the transmission channels, the authors found that a strong ESG profile leads to increased competitive advantages, higher profitability potential, and higher dividends for the investors. The authors find that companies with strong ESG profiles have low systematic risk and lower cost of capital, which will result in a higher valuation. However, not all findings are consistent with a positive correlation between ESG and performance. Research by Mănescu found that there was no statistical significance of the aggregate ESG factors on stock returns (Mănescu, 2011). It did find that social responsibility did have a positive correlation on returns from 1992-2003, but for 2003-2008 there was an inverse correlation. La Torre et al. (2020) reach a similar conclusion in their investigation of how ESG ratings affect stock returns. The findings indicate that the correlation between ESG ratings and stock returns is very weak or absent. Most of the positive correlation observed is concentrated in the energy and utility sectors. The authors speculate that these benefits from higher ESG ratings result from ESG investments being more significant to company profitability in these industries, without offering an explanation as to why this is the case. These findings are significant as they reject the idea of ESG and excess returns as positively correlated, suggesting that positive results may be industry-specific.

Based on these conclusions, we should expect a positive influence on ESG factors, but it should not be a complete surprise if we find no significance or inverse relation. ESG influence significance may depend on the firm's industry. Energy and utility firms particularly are generally

less sustainable as a direct result of the products and services they provide. As a result, investors may be more concerned with how they expect to remain sustainable over the long-term. Additionally, firms in these sectors with relatively high ESG ratings will likely face less regulation-based issues. Our research could help provide evidence to the contradicting conclusions found by prior researchers and provide more clarity on the subject,

Factor Analysis

As ESG is comprised of multiple factors, it is essential to understand each factors' contribution (or lack thereof) to increased performance, as well as their relationship with one another. A subset of data from Australia collected by Limkriangkrai et al. (2017) seeks to investigate the effects of ESG's independent factors as well as the combined rating effects on the Australian Equity market. The test statistic demonstrates that the difference between E(G) is significant, and S(G) is insignificant. They find in the overall market, there is little evidence to substantiate that ESG factors provide abnormal returns. Miralles-Quirós et al. (2019) consider a narrower view, studying each factors' impact on the banking sector. They highlight the importance of environmental performance for stakeholders, concluding that the bank's social performance does not causally relate to financial stakeholders.

In contrast, environmental and governance performance is positively related to share price. A paper by Nollet et al. (2016) supports some of these results while disputing others. The study investigates the relationship between social and corporate performance (both firm performance and stock returns). The results indicate that initial ESG investments decrease financial performance until a certain threshold is met. No link could be made between excess returns and ESG, but some firm performance gains could be attributed to governance factors. Comparable results are observable in an article by Meher et al. (2020), which assesses the impact of ESG ratings on volatility and returns of Indian companies. Only governance was positive. The paper concludes that ESG scores in this sample led to lower returns but also lower volatility. Khan et al. (2015) further indicate a divide in financial value between factors by examining the firm-value differences

between high and low ESG scoring firms. According to the paper, firms with strong ratings on material ESG issues had significantly greater returns than firms with worse ratings. Firms with strong scores on immaterial ESG issues did not outperform firms with low scores. With this in mind, the preceding literature relates to the question at hand by granting insight into which scoring factors provide the most return to firms and why this is the case.

This subject relates directly to our second hypothesis testing, where we will test the influence of each ESG factor. Based on the previous research, we might expect that governance to be the most significant factor in our modified Farma-French model, while the other factors may not contribute much to the excess returns. Part of this could be due to ESG factors reducing risk and thus requiring lower compensation resulting in lower returns.

Risk/Return Profiles

A potential major benefit of ESG is its ability to reduce risk, potentially meaning high ESG stocks could offer superior risk-adjusted returns. Research completed by Maiti indicates a statistical significance of ESG factors in Europe with a 95% confidence level (Maiti, 2020). Maiti also proved that the Farma-French 3-factor model could now be improved with ESG as a factor, where the three factors should be: Market risk premium, Firm size, and ESG factors. This is supported by Sherwood, M., & Pollard, J. (2017), who focus on estimating the performance potential of integrating ESG research within the emerging markets investment strategies. After integrating ESG strategies, companies and indices show lower risk profiles as well as higher returns than non-ESG MSCI Indices. These results can be explained by research examining each industry and how participating in ESG activities affected the risk of the firm. It is shown that engagement in ESG activities reduces firm risk, as it means reducing the costs of insurance-like protection, improved risk management, and transparency (Cai, 2016).

In contrast, research covering Swedish and Norwegian funds that excluded firms that did not meet ethical standards from the investment universe (like picking high ESG rated firms) found

that there was no significant difference in performance (Hoepner, Schopohl, 2018). Researchers suggested the reason for the performance despite excluding firms could be due to unethical firms having more risk than ethical firms. The researchers also brought up the ethics criteria and are subjective from person to person, and that actions of firms judged by professionals evaluating the firm could differ and change the results. Jain et al. (2019), another contradictory study, states that there is no significant difference between ESG and non-ESG indices returns, and they should be combined for optimal performance. The study concluded that ESG indices have co-integrated returns with non-ESG indices - Meaning returns from ESG indices impact non-ESG indices due to the flow of information between the two markets. Additionally, there is evidence of volatility spillover to further back up this claim, as well as finding no significant difference in the performance of ESG and non-ESG indices.

Based on prior research, we should expect our ESG portfolio to have lower risk/volatility, which might explain the inconsistency with what other researchers have found about returns and ESG factor significance. ESG firms having lower risk may affect the firms from outperforming due to lower compensation for their risk. However, if ESG stocks have similar returns to non-ESG stocks but lower risk, this would indicate that ESG stocks have a better Sharpe (Reward/Risk) ratio and should be preferred over other stocks.

Disclosures

The way in which ESG related factors are reported by companies must be considered when conducting ESG research. A paper by Tamimi and Sebastianelli (2017) explores the relationship between transparency and ESG disclosure scores by asking if firms are more transparent in reporting favorable ESG scores, whether ESG scores are more prevalent in specific industries, and how transparency is affected by governance practices. The major findings show that for firms listed on the S&P, the highest transparency in scores existed for governance and the lowest for environmental scores. The contribution of these findings to the field of ESG research gives a window into expected ESG scores and can grant additional aid in studying which elements of the

firm's returns can be tied back to their ESG scores. Next, Aureli and Gigli's (2019) work, focusing on the DJIA, explains the relation between firm sustainability practices and financial performance. Results from the study showed two significant event windows, including four days before and four days after the release of a firm's significant report. The study also found that 2013 was a tipping point in the ESG perception timeline as the number of value relevant ESG disclosures after 2013 increased. The authors pointed out that after 2013 the number of nonsignificant sustainability reports dropped by around 40% from 73 to 44.

This research shows that companies provide the most transparency when reporting their governance practices, which could be an important conclusion to remember when analyzing the different factors' effects on performance. This may be a result of companies believing governance is the most critical ESG factor in regards to their stock price, which is supported by some of the studies in the factor analysis section. Alternatively, they may be finding it more difficult to effectively improve their social and environmental performance, and as a result, are less inclined to share that information. Furthermore, the finding that ESG disclosures are becoming increasingly relevant to investors indicates that ESG factors may significantly impact firm value.

Investor Sentiment

Even if ESG investment does not improve firm performance, if investor demand increases in relation to ESG conscious firms, their stock prices will surge. As a result, it is necessary to consider investor sentiment. Cao et al. (2019) state that investors' tastes have significantly changed over the past 20 years. Their paper focuses on how quantitative and socially responsible (SR) investment strategies have influenced stock return patterns. Cao et al. (2019) found that SR investors have significantly different portfolios than non-SR investors. Specifically, the authors find that SR investors hold portfolios with lower turnover and stocks that are less sensitive to quantitative symbols. Egli and Maule (2017) specifically consider asset managers in their paper. They examine how asset managers have adapted to the shift towards more sustainable development. The authors conclude that asset owners (pension funds, insurers, banks) who hire

asset managers with dedicated ESG staff perform better than those who have no or little ESG expertise at their disposal.

Additionally, asset managers who engage more with the ESG firms they invest in perform significantly better. More information on asset managers' ESG approach is included in an article by van Duuren et al. (2015). Investors prefer individual ratings to industry-wide ratings, choosing to use the ratings holistically. Governance is of most importance to professional asset managers, whereas environmental and sustainability issues are more important to retail investors. While the preceding articles suggest positive ESG investing sentiment, there has been research looking into the negative aspects of ESG investors. A study by Cui and Docherty found that investor behaviors are affecting ESG prices concerning the Salience theory. This means that investors weigh extreme ESG news cases more heavily in their pricing, and overreactions or emphasis on ESG stocks is generating some percentage of returns. They also found that negative news that brings the returns down will return to the mean within 90 days (Cui, Docherty, 2020).

These investor sentiment related articles reach several conclusions relevant to our research. Importantly, it appears as though investors and asset managers do consider ESG ratings and those who report that ESG factors significantly influence their investment decisions seem to perform better. This suggests that ESG conscious firms may outperform their peers. Additionally, governance appears to be the most crucial factor to asset managers, indicating that this factor has a more considerable relative impact on stock returns.

Research Question and Hypothesis Development:

All three factors of the ESG model are intimately tied to responsible investment – the method highly demanded by the market and millennials, in specific. Hence, all investors are figuring out whether this responsible investment strategy pays off. The world's biggest financial markets have all leaped to provide ESG relevant rating indexes. There are now five major indices:

Dow Jones Sustainability Index, the FTSE4Good Index, Bloomberg ESG data, the MSCI ESG Indices, and the GRESB benchmarks; ESG investing is now becoming an official investment strategy with its own pros and cons. Hence, in this paper, we are trying to figure out the relationship between the Environmental, Social, and Governance (ESG) performance of the publicly-traded company and its stock performance. Therefore, the question we raise in this article is, "Do the markets effectively price a firm's ESG score?" Additionally, this paper will identify whether individual ESG factors have a greater effect on a firm's price than others.

Academics have researched various outcomes of ESG investing strategy; for example, Zhao et al. (2018) and Sherwood (2017) found and provided statistical and financial backing that in the emerging markets, high ESG performance stocks are usually providing better returns to investors than low ESG performance stocks. Moreover, Friede et al. (2015) found a direct positive correlation between higher ESG scores and the company's positive financial performance. Although Mănescu (2011) did not find any significant statistical relationship between ESG performance and the company's stock returns, we believe that there is a direct relationship between abnormal returns and ESG performance of a publicly-traded company. Hence, our main hypothesis is:

H0: There is no relation between abnormal returns and the ESG performance of a firm.

H1: There is a significant relationship between abnormal returns and the ESG performance of a firm.

Our main hypothesis targets research on the effect of a composite ESG score on returns of a firm. After reviewing relevant research articles, we realized that current literature fails to answer whether any ESG models' factors are more valuable to investors. Modern-day retail or institutional

investor needs to consider whether stock returns systematically differ for firms rated into low, mid, or high groupings for each of the individual Environmental, Social, or Governance components of a composite ESG performance. Aureli and Gigli (2019) found in their research that investors tend to react to the significant sustainability reports' publications positively and that the market's reaction has increased in the last couple of years. However, we were specifically curious about whether any of the central factors in measuring a company's sustainability and societal impact is dominant in estimating ESG score. Thus, our secondary hypotheses are:

H0(a): Environmental factor is priced higher within the ESG model.

H0(b): Social factor is priced higher within the ESG model.

H0(c): Governance factor is priced higher within the ESG model.

H1: All factors are optimally priced within the ESG model.

The testing of these hypotheses will provide enough statistical evidence and will try to answer our research question.

Data and Methodology:

Data

The data gathered for this study was done by sampling Russell 3000 between July 2010 and July 2020. From the index, monthly and yearly data were sampled from 1431. firms. Monthly return data was gathered from Bloomberg by gathering prices at the beginning of the month. To examine whether a firm's ESG score has been effectively priced into its stock, a variety of independent was used to single out the effects of ESG. These independent variables

were gathered annually and consisted of: Market Capitalization (MC), Market Capitalization to Book (MCB), Market Risk Premium (MRP), Bloomberg ESG Score (ESG), Bloomberg Environmental (Env), Bloomberg Social (Soc), and Bloomberg Governance (Gov).

Methodology

Similar to Maiti (2020), this study uses Bloomberg ESG scores to identify the relationship between the sampled firms' returns and their ESG score. Modeled after Fama and French's (1993) methodology, we will analyze whether ESG variables are effectively priced into a stock price. To do this, we will construct six equal weight portfolios to control for small minus big (SMB) and high-minus-low (HML) factors. These portfolios are constructed each July by segregating all of the stocks in each index by their MC and their MCB ratios. To segregate by MC, we divide the top 50 percentile into a "Big" category and the bottom 50 percentile into a "Small" category. We then segregate the MCB by dividing the top 70th percentile into a "Value" category, the bottom 30th percentiles into a "Growth" category, and the remainder into a "Neutral" category. We then create the portfolios by taking the intersection of the firms in the size and value categories and defining them by their growth and value.

	Median MC (50th percentile)	
70th Percentile MCB	Small Value (SV)	Big Value (BV)
30th Percentile MCB	Small Neutral (SN)	Big Neutral (BN)
	Small Growth (SG)	Big Growth (BG)

To calculate the SMB factor, we calculate the average monthly returns for each small portfolio and subtract the average monthly returns of the big portfolios. This captures the size effect as both big and small portfolios have exposure to value and growth, which leaves only the

size factor left. We then calculate HML by taking the average monthly return of the value portfolio and subtracting it from the average monthly returns of the growth portfolio. This allows us to examine the value effect on stocks we eliminate the growth factor while also having equal exposure to size. We then conclude the traditional construction of the Fama French (1993) model by calculating the MRP by taking the cumulative monthly returns and subtracting them from the risk-free rate. This allows us to account for the extra return for investing in a risky asset to compensate investors for the additional risks taken.

$$SMB = \frac{SV + SN + SG}{3} - \frac{BV + BN + BG}{3}$$

$$HML = \frac{SV + BV}{2} - \frac{SG + BG}{2}$$

Our study differs from the traditional factor models as we assert that investors should be compensated for investing in firms that exhibit more corporate social responsibility (CSR) than their peers. We construct 16 new portfolios to capture the effects of ESG using a similar manner to Maiti (2020) and Kahn et al. (2015). Specifically, we define firms who are above the 70^{th} percentile ESG scores as 'Responsible" (R) and those in the bottom 30^{th} percentiles as "Misguided" (M). We then calculated the difference between the monthly returns of Big (B) and Small (S) scores to analyze the significance of the factors. We then control for value risk stocks by using Maiti's (2020) methodology of taking the difference between Responsible and Misguided ESG firms.

$$ESG = \frac{SR_{ESG} + BR_{ESG}}{2} - \frac{SM_{ESG} + BM_{ESG}}{2}$$

$$Env = \frac{SR_{Env} + BR_{Env}}{2} - \frac{SM_{Env} + BM_{Env}}{2}$$

$$Soc = \frac{SR_{Soc} + BR_{Soc}}{2} - \frac{SM_{Soc} + BM_{Soc}}{2}$$

$$Gov = \frac{SR_{Gov} + BR_{Gov}}{2} - \frac{SM_{Gov} + BM_{gov}}{2}$$

With the portfolios constructed, we can now regress the independent variables onto our sample's monthly returns. We construct a panel study of our sample by expanding on the traditional Fama-French (1993) model to analyze the effects of the overall ESG scores and the individual ESG scores. The first two models that will capture the SMB and HML factors while also accounting for ESG. These models differ from each other as the first one captures the effects of ESG as a whole while the second one captures each specific factor's impact.

$$R_i - R_F = \alpha + \beta_1 MRP + \beta_2 SMB + \beta_3 HML + \beta_4 ESG + \varepsilon_i$$

$$R_i - R_F = \alpha + \beta_1 MRP + \beta_2 SMB + \beta_3 HML + \beta_4 Env + \beta_5 Soc + \beta_6 Gov + \varepsilon_i$$

We then expand on this analysis by identifying if fixed effects such as the firm's sector has an effect on a firm's pricing of ESG. Specifically, we assert that different sectors will price ESG factors differently as the demand for firms to be good corporate citizens will depend on the industry. We create models by using the backward elimination technique to eliminate insignificant sector variables. Similar to the previous equations, we produce two more formulas in which the first model includes the total ESG variable, and the second one includes each individual ESG factor.

$$R_i - R_F = \alpha + \beta_1 MRP + \beta_2 SMB + \beta_3 HML + \beta_4 ESG + \beta_5 Energy + \beta_6 Financials + \beta_7 Materials + \beta_8 Real\ Estate + \beta_9 Utilities + \varepsilon_i$$

$$R_i - R_F = \alpha + \beta_1 MRP + \beta_2 SMB + \beta_3 HML + \beta_4 Env + \beta_5 Soc + \beta_6 Gov + \beta_7 Energy + \beta_8 Financials + \beta_9 Materials + \beta_{10} Real\ Estate + \beta_{11} Utilities + \varepsilon_i$$

Results:

ESG Regression Results:

Our first test was to on the ESG factor to see if it was significant at explaining abnormal returns. The regression used, the Fama-French 3 factor model with the additional ESG factor (total four factors), we would that all factors used in the model had statistical significance and had an R^2 of ~49%. Meaning 49% of our dependent variable is explained by our independent variables, which would be considered a substantial explanation in the most research literature. The table below shows the results of our first regression testing the ESG factor.

PanelOLS Estimation Summary

Dep. Variable:	IndividualPremium	R-squared:	0.4938
Estimator:	PanelOLS	R-squared (Between):	6.661e-16
No. Observations:	170640	R-squared (Within):	0.4938
Date:	Wed, Dec 02 2020	R-squared (Overall):	0.4919
Time:	22:02:20	Log-likelihood	1.772e+05
Cov. Estimator:	Clustered		
		F-statistic:	4.126e+04
Entities:	1431	P-value	0.0000
Avg Obs:	119.25	Distribution:	F(4,169214)
Min Obs:	0.0000		
Max Obs:	120.00	F-statistic (robust):	2.463e+04
		P-value	0.0000
Time periods:	120	Distribution:	F(4,169214)
Avg Obs:	1422.0		
Min Obs:	1422.0		
Max Obs:	1422.0		

Parameter Estimates

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
Intercept	0.0018	0.0002	11.174	0.0000	0.0014	0.0021
RiskPremium	1.0130	0.0033	307.52	0.0000	1.0066	1.0195
HML	-0.2400	0.0233	-10.286	0.0000	-0.2857	-0.1943
SMB	0.8922	0.0232	38.431	0.0000	0.8467	0.9377
ESG	0.0867	0.0184	4.7026	0.0000	0.0505	0.1228

The statistical significance evidence can be seen in the "Parameter Estimates" section under the T-stat and P-value columns. The P-values were all less than 5% leading us to reject the null hypothesis and accept that the factors are significant. As well as under the T-stat, all values were either above 1.96 or below -1.96, again, leading us to reject the null hypothesis and accept that the factors are significant. Under the parameter column, we have our Betas, which show the correlation (positive/negative) and how much each factor portfolio affected our panel/portfolio of stocks. The Beta can be interpreted as: for every unit increase in the factor (MRP, SMB, HML,

ESG) portfolio, abnormal returns in the portfolio increase by its respective beta value. Only the HML had a negative correlation with our portfolio, while the rest of the factors had positive relations. The MRP (market risk premium) had the most significant correlation, followed by SMB, and lastly, the ESG factor.

Analysis of ESG Regression Result:

The positive MRP correlation is expected because firms with high exposure to market factors (ex: changes in interest rates, the strength of the economy) which increases the risk the firm is exposed to. Investors should be compensated for that risk. This is supported by the CAPM model (Sharpe, 1964) and the Fama French 3 factor model (1993).

The SMB positive correlation was also expected because small firms hold more uncertainty and risk than established large-cap. Firms. Investors should be compensated for holding more risk of small firms. This analysis is supported by Fama and French 3 factor model (1993).

However, the HML negative correlation was not an expected result of our test. This negative correlation could have been due to there being significantly lower book-to-ratio firms in our sample/panel/portfolio. It could also be that our research has provided that there is a change in what investors are rewarded for, and maybe investors are no longer rewarded by taking risks of holding onto firms that have a high book-to-market ratio, which shows higher distress (a theory on HML premium). Another interpretation of HML is that it suggests that the firm is undervalued. Our research may indicate that investors have already exploited this theory and that "value" stocks now are not undervalued anymore.

Moving onto the ESG factor, it has the lowest correlation of all the factors, which makes when the theory of ESG creating abnormal returns is that the ESG ethical actions indirectly affects returns. Since they are indirectly affecting the returns, we do not expect ESG to have the most robust relationship.

Individual ESG Factor Regression Result:

Next, we tested each of the ESG factors: Environment, Social & Governance factors (as explained in the methodology section). Again, we saw an R^2 of ~ 49% furthering supporting the validity of the regressions, and all factors were statistically significant.

PanelOLS Estimation Summary

Dep. Variable:	IndividualPremium	**R-squared:**	0.4938
Estimator:	PanelOLS	**R-squared (Between):**	5.551e-16
No. Observations:	170640	**R-squared (Within):**	0.4938
Date:	Wed, Dec 02 2020	**R-squared (Overall):**	0.4919
Time:	22:02:18	**Log-likelihood**	1.772e+05
Cov. Estimator:	Clustered		
		F-statistic:	2.751e+04
Entities:	1431	**P-value**	0.0000
Avg Obs:	119.25	**Distribution:**	F(6,169212)
Min Obs:	0.0000		
Max Obs:	120.00	**F-statistic (robust):**	1.654e+04
		P-value	0.0000
Time periods:	120	**Distribution:**	F(6,169212)
Avg Obs:	1422.0		
Min Obs:	1422.0		
Max Obs:	1422.0		

Parameter Estimates

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
Intercept	0.0018	0.0002	11.638	0.0000	0.0015	0.0021
RiskPremium	1.0158	0.0033	307.71	0.0000	1.0093	1.0223
HML	-0.2203	0.0236	-9.3249	0.0000	-0.2666	-0.1740
SMB	0.8878	0.0231	38.467	0.0000	0.8426	0.9330
ENV	0.0903	0.0256	3.5249	0.0004	0.0401	0.1405
SOC	-0.0983	0.0318	-3.0877	0.0020	-0.1608	-0.0359
GOV	0.0952	0.0228	4.1804	0.0000	0.0506	0.1399

The statistical significance evidence can be seen in the "Parameter Estimates" section under the T-stat and P-value columns. The P-values were all less than 5% leading us to reject the null hypothesis and accept that all factors are significant. As well as under the T-stat, all values were either above 1.96 or below -1.96, again, leading us to reject the null hypothesis and accept that all factors are significant. Under the parameter column, we have our Beta's, which show the

correlation (positive/negative) and how much each factor portfolio affected our stocks' panel/portfolio. The Beta can be interpreted as: for every unit increase in the factor (MRP, SMB, HML, E, S, G) portfolio, abnormal returns in the portfolio increase by its respective beta value. Only the HML & Social factors had a negative correlation with our portfolio, while the rest of the factors had positive relations. The MRP (market risk premium) had the most significant correlation, followed by SMB, and lastly, the ESG factor.

Analysis of the Individual ESG Factor Regression Results:

The alpha in both tests was 0.18% and was statistically significant, meaning that there is a slight non-random error in the regression. It means that when all factors have zero returns, that our portfolio would still have an abnormal return 0.18%. This could mean that there is a factor that we have not identified that explains some of the abnormal returns.

The Beta's of the MRP, SMB, and HML factors have slightly changed between tests. The changes are minimal and could be due to statistical reasons (for example, more factors in the model).

Again, the HML was negative, which was not originally anticipated at the beginning of the research. This result has stayed consistent with our current findings (from the ESG regression) and may confirm the theory that HML may no longer be a risk factor that investors are rewarded for taking.

Corporate governance and environment factors had a positive correlation with abnormal returns. Corporate governance being the largest positive factor comes to no surprise, as higher corporate governance means a higher probability of the firm doing what is in the shareholders'

best interest. Therefore, if a firm is doing what shareholders desire, it will generate demand for the stocks. Higher corporate governance and a higher probability of obedience to shareholders' demands mean that shareholders would have more control over the firm than shareholders who hold firms with lower corporate governance. Since the underlying value of holding a stock is that the shareholder essentially/theoretically has ownership and control over those firms. Firms that deviate further from this theory of ownership lose value because shareholders have less ownership/control. As for the environmental factor, the positive correlation with abnormal returns can be due to the recent trend in environmental impact awareness of investors and consumers that corporations have.

The social factor had the highest correlation but was also the only negative ESG factor. Some of this could be explained by investors who may assume that corporations with high environmental scores also have high social scores, which may not always hold true. Another explanation is that investors do not care that much about the social factor. Alternatively, a combination of the two theories, investors and corporations may be too focused on the environmental impact and other details of running a profitable business that they are not focusing on the social factors. Hence, the negative correlation meaning that firms that push their employees to work hard and give less compensation have a greater ability to generate higher returns.

Results of Dummy Variables – ESG Factor:

We tested to see if sectors had significantly different returns from each other. This could be done using dummy variables, where the dummy variable value would affect the intercept of

the regression for the sector to indicate how a sector on average differs from the rest of the sectors. See the table below for results on dummy variables under the "Parameters column". As the reader can see from the table, the following sectors had different abnormal returns on average: Consumer Discretion (+0.17%), Energy (-0.70%), Financials (-0.19%), Healthcare (+0.30%), Information technology (+0.25%) and Real estate (-0.24%).

PooledOLS Estimation Summary

Dep. Variable:	IndividualPremium	R-squared:	0.4923
Estimator:	PooledOLS	R-squared (Between):	0.0947
No. Observations:	170640	R-squared (Within):	0.4938
Date:	Wed, Dec 02 2020	R-squared (Overall):	0.4923
Time:	22:02:21	Log-likelihood	1.767e+05
Cov. Estimator:	Unadjusted		
		F-statistic:	1.654e+04
Entities:	1431	P-value	0.0000
Avg Obs:	119.25	Distribution:	F(10,170629)
Min Obs:	0.0000		
Max Obs:	120.00	F-statistic (robust):	1.654e+04
		P-value	0.0000
Time periods:	120	Distribution:	F(10,170629)
Avg Obs:	1422.0		
Min Obs:	1422.0		
Max Obs:	1422.0		

Parameter Estimates

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
const	0.0017	0.0004	4.3110	0.0000	0.0009	0.0025
SMB	0.8922	0.0143	62.209	0.0000	0.8641	0.9203
HML	-0.2400	0.0185	-12.982	0.0000	-0.2762	-0.2038
RiskPremium	1.0130	0.0028	367.06	0.0000	1.0076	1.0185
ESG	0.0867	0.0154	5.6184	0.0000	0.0564	0.1169
Consumer Discretionary	0.0017	0.0007	2.4192	0.0156	0.0003	0.0031
Energy	-0.0070	0.0011	-6.2728	0.0000	-0.0092	-0.0048
Financials	-0.0019	0.0006	-3.2382	0.0012	-0.0030	-0.0007
Health Care	0.0030	0.0007	4.3072	0.0000	0.0016	0.0044
Information Technology	0.0025	0.0007	3.5521	0.0004	0.0011	0.0038
Real Estate	-0.0024	0.0009	-2.6311	0.0085	-0.0042	-0.0006

Results of Dummy Variables – Individual ESG Factors:

The dummy variables for when we conducted the same tests but broke down the ESG into its individual factors, we found: Energy (-0.87%), Financials (-0.35%), Materials (0.30%), Real estate (-0.41%), and Utilities (-0.31%). See the table below, under the "parameters" column.

PooledOLS Estimation Summary

Dep. Variable:	IndividualPremium	R-squared:	0.4923
Estimator:	PooledOLS	R-squared (Between):	0.0873
No. Observations:	170640	R-squared (Within):	0.4938
Date:	Thu, Dec 03 2020	R-squared (Overall):	0.4923
Time:	15:56:40	Log-likelihood	1.767e+05
Cov. Estimator:	Unadjusted		
		F-statistic:	1.504e+04
Entities:	1431	P-value	0.0000
Avg Obs:	119.25	Distribution:	F(11,170628)
Min Obs:	0.0000		
Max Obs:	120.00	F-statistic (robust):	1.504e+04
		P-value	0.0000
Time periods:	120	Distribution:	F(11,170628)
Avg Obs:	1422.0		
Min Obs:	1422.0		
Max Obs:	1422.0		

Parameter Estimates

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
const	0.0034	0.0003	11.154	0.0000	0.0028	0.0040
SMB	0.8878	0.0144	61.501	0.0000	0.8595	0.9161
HML	-0.2203	0.0194	-11.329	0.0000	-0.2585	-0.1822
RiskPremium	1.0158	0.0028	364.55	0.0000	1.0103	1.0213
ENV	0.0903	0.0229	3.9462	0.0001	0.0454	0.1351
SOC	-0.0983	0.0244	-4.0287	0.0001	-0.1462	-0.0505
GOV	0.0952	0.0217	4.3858	0.0000	0.0527	0.1378
Energy	-0.0087	0.0011	-7.9370	0.0000	-0.0108	-0.0065
Financials	-0.0035	0.0005	-6.6811	0.0000	-0.0046	-0.0025
Materials	-0.0030	0.0009	-3.1379	0.0017	-0.0048	-0.0011
Real Estate	-0.0041	0.0009	-4.5931	0.0000	-0.0058	-0.0023
Utilities	-0.0031	0.0012	-2.6535	0.0080	-0.0053	-0.0008

Analysis of the Dummy variables:

The dummy variables changed between tests, meaning the sectors that were not consistent in both could tell that they did not, in fact, have statistically different abnormal returns

from the regression model. The consistent sectors were: Energy, Financials, and Real estate, which all performed worse than the rest of the sectors on average. These results suggest that these sectors are not as robust as the other sectors. Dummy variables have also differed between tests, but only slightly (0.16% - 0.17%) difference, which could be due to statistical reasons.

Results of the Dummy Interactive Variables:

The interactive tells us how a sector is affected by the factors used (MRP, SMB, HML, E, S & G) differs from the rest, or in other words, how a sector is impacted differently from the factor. We found that some sectors treat the social factor differently, as only the SOC factor was significant (please see table below under "parameters" column). The following dummy interactive variable were found significant: SOC Energy (+82.21%), SOC Financials (-27.00%), SOC Materials (+78.58%), SOC Real estate (-0.84%) and SOC utilities (-31.03%).

PooledOLS Estimation Summary

Dep. Variable:	IndividualPremium	R-squared:	0.4932
Estimator:	PooledOLS	R-squared (Between):	0.0873
No. Observations:	170640	R-squared (Within):	0.4948
Date:	Wed, Dec 02 2020	R-squared (Overall):	0.4932
Time:	23:05:11	Log-likelihood	1.768e+05
Cov. Estimator:	Unadjusted		
		F-statistic:	1.038e+04
Entities:	1431	P-value	0.0000
Avg Obs:	119.25	Distribution:	F(16,170623)
Min Obs:	0.0000		
Max Obs:	120.00	F-statistic (robust):	1.038e+04
		P-value	0.0000
Time periods:	120	Distribution:	F(16,170623)
Avg Obs:	1422.0		
Min Obs:	1422.0		
Max Obs:	1422.0		

Parameter Estimates

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
const	0.0034	0.0003	11.149	0.0000	0.0028	0.0040
SMB	0.8878	0.0144	61.558	0.0000	0.8595	0.9161
HML	-0.2203	0.0194	-11.339	0.0000	-0.2584	-0.1822
RiskPremium	1.0158	0.0028	364.89	0.0000	1.0103	1.0213
ENV	0.0903	0.0229	3.9498	0.0001	0.0455	0.1351
SOC	-0.1042	0.0274	-3.7968	0.0001	-0.1579	-0.0504
GOV	0.0952	0.0217	4.3898	0.0000	0.0527	0.1378
Energy	-0.0081	0.0011	-7.4652	0.0000	-0.0103	-0.0060
Financials	-0.0037	0.0005	-6.9989	0.0000	-0.0047	-0.0027
Materials	-0.0025	0.0009	-2.6178	0.0088	-0.0043	-0.0006
Real Estate	-0.0041	0.0009	-4.5983	0.0000	-0.0058	-0.0023
Utilities	-0.0033	0.0012	-2.8212	0.0048	-0.0055	-0.0010
SOC Energy	0.8221	0.0815	10.084	0.0000	0.6623	0.9818
SOC Financials	-0.2700	0.0395	-6.8372	0.0000	-0.3475	-0.1926
SOC Materials	0.7858	0.0706	11.136	0.0000	0.6475	0.9242
SOC Real Estate	-0.0084	0.0659	-0.1280	0.8982	-0.1377	0.1208
SOC Utilities	-0.3103	0.0861	-3.6053	0.0003	-0.4791	-0.1416

Analysis of the Interactive Dummy Variables:

The results suggest that Energy, Financials, Materials, Real estate, and Utilities are influenced differently by the social than the rest of the sectors. While most sectors decrease by 10.42% in abnormal returns for each unit of return from the social factor portfolio, the financials, real estate, and utilities experience a decrease even further.

However, when the interactive dummy variable is considered, the energy and materials sectors positively correlate with the social factor. This could be due to the labor in the energy/materials sectors being harsher than the average sector, thus leading investors to take notice and care more about employees are treated. Zhao et al. (2018) also found positive correlations between the ESG score and returns in the energy sector. Another reason for materials and energy having positive correlations could be the social factors; one of the criteria for measuring the social score is how the firm impacts the community. If a firm's operations affect a local community's environment, the correlation may have more to do with environmental impact than the social impact. For example, for a manufacturing company (in the materials sector), pollution may affect the community, which will affect its social score.

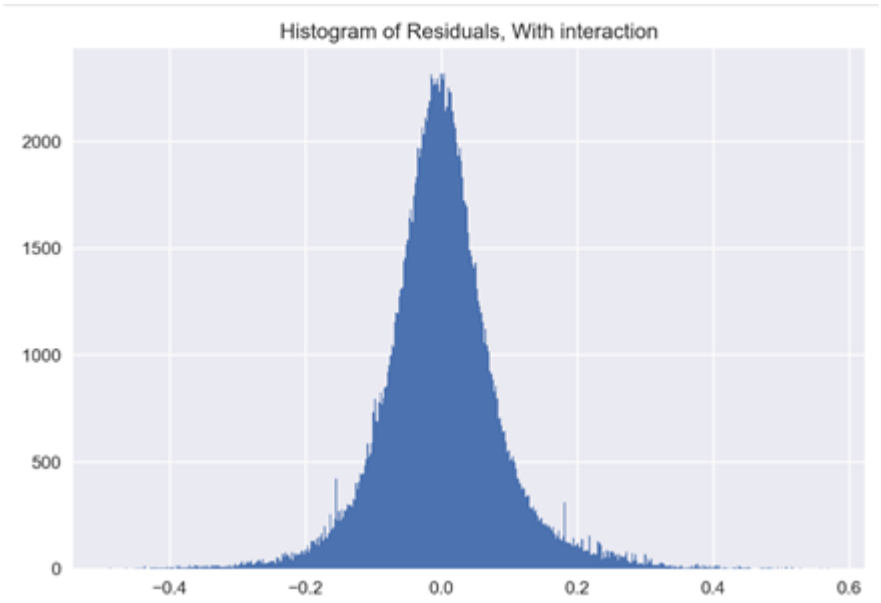
OLS-Estimation Assumptions:

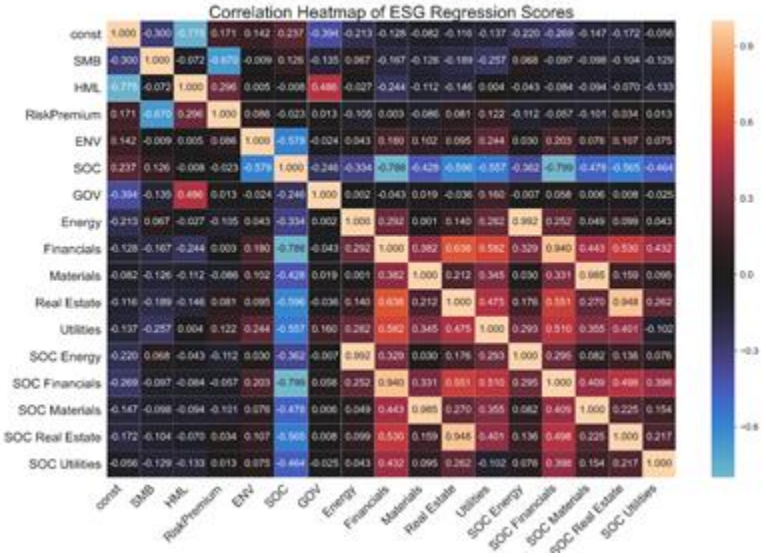
There are three assumptions that need to hold for the OLS-estimations:

1. No perfect multicollinearity
2. Error expected value = 0
3. None of the factors are significantly correlated

In our model, our error terms had an average of zero, with a normal distribution. This is good because it suggests that the errors in our regression are random and that there are no patterns or factors that create these errors. There are no strong correlations, where there are strong correlations, they are expected because the correlations are from the factors themselves—for example, the SOC energy correlation with Energy or Energy correlation with Energy. Because

our assumptions hold, OLS is consistent. The regression coefficients are asymptotically unbiased. (see charts below).





Limitations:

Primary limitations found during research development are six-fold. The first to address is that of coding errors within the data collection process. While having the experience and expertise to obtain the data through Python, there remains the limiting factor that is accidentally and unknowingly neglecting to include a parameter may skew results, preventing an accurate interpretation. While unlikely, the more probabilistic data error is due to ESG reporting and valuation in the open market. Firms have no obligation to report on ESG outside of legally required metrics and even published ESG scores may have some embellishment within them to look more favorable upon investors. Tying into this, ESG valuation is a very subjective matter as the scores have no dollar value but are shown to be priced into the market, which relies on a qualitative value of scores by shareholders, which could present issues if a firm were to a) overstate their score, and b) investors misprice the value of the score.

The next set of limitations comes in the form of statistical analysis through panel studies and OLS (Regression). The models utilized in this study assume that unique attributes remain constant over time and may require additional tests to ensure data's robustness. In addition to this, the OLS limitations include linearity assumptions that assume there must be an explicit dependent-independent relationship, which is not always a correct assumption. Furthermore, heteroscedasticity was noted while analyzing the cleaned data. At times, it became difficult to identify bounds as plotted residuals interfered with visual representation as the variability of variables is unequal across the range of dependent values.

Further, in removing extreme values from the cleaned data while making for a more robust data set may have worked against data interpretation at times as data that would naturally influence the set was cut. Lastly, the final limitation we encountered was that of time. ESG has become a

much more prominent factor in the last decade as more firms engage in reporting; however, data collection becomes exceedingly difficult in time periods greater than ten years. While finding that ESG is priced in, the data is based upon the longest bull run in history where this data was difficult to obtain in periods prior to the current decade.

Future Considerations

Some future considerations for research-based upon the limitations and issues encountered would be to recommend testing on a broader range of indices, as well as potentially to examine foreign exchanges in Europe. In doing so, one could examine the trends of different markets to see if ESG factors are priced differently by market and country. This would allow for a more robust result based on a more global portfolio. While this analysis proved significant and robust in the examined market, testing on a global scale would allow for a more generalized conclusion on global ESG importance. Additionally, further testing and analysis could allow for an elimination of the bounded residuals, which may lead to different results but may work to further explain the relationship between ESG factors and their pricing into publicly traded securities. In reiterating the previous section's discussion on heteroscedasticity, while the results of this research are grounded and within reason to be trusted, further research should be on the lookout for heteroscedasticity amongst residuals to avoid a situation where regression results must be rejected

Conclusion:

The result of regressions suggests ESG is a statistically significant factor in explaining the abnormal returns of our sample portfolio, with ESG possessing a positive correlation with returns. Through the in-depth review, it was noted that only corporate governance and environmental factors had positive correlations. Simultaneously, there were negative correlations

often associated with the social factor, apart from the energy and materials sector, which held a positive correlation with social factors. Zhao et al. (2018) also found positive correlations between the ESG score and returns in the energy sector. Overall, the positive ESG factor correlations make sense with the increased demand for stocks that have ESG ratings. The positive environmental factor can also be related to the increase in awareness on environmental impact, whereas positive corporate governance correlations make sense because high corporate governance in a firm means a higher probability of shareholders having control, and thus doing what is in the best interest of the shareholders, effectively increasing shareholder wealth via stock value.

It is difficult to identify why there exists a negative correlation with the social factor, as there has been a substantial increase for social justice in a sense, as can be seen by the recent controversies with mask-wearing and COVID-19, morals with recent presidencies and the Black Lives Matter movement. However, these protests and controversies among modern society do not directly transfer to the same voices influencing stock demands. As such, the negative relationship could indicate that investors do not care about social scores; or perhaps the sample portfolio did not capture an accurate sample of firms.

We also found that our sample portfolio had three sectors (Financials, Energy & Real Estate) that had statistically significant different abnormal returns on average the other sectors. Additionally, our regressions also had an R^2 of 49%, meaning that our independent variables were able to explain 49% of the dependent variable (abnormal return) values. An R^2 of 49% is substantial in the research community, thus granting credibility to our research results.

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Student ID: 101123525
Assignment Title: Research Proposition - ESG
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I declare that the work submitted in the attached review is my work. None of the attached manuscript has been copied from other people's work All sources and articles used for this work have been referenced in the footnotes, endnotes, or bibliography.
Student Name: Jacob Lindblad
Student ID: 101072151
Assignment Title: Research Proposition - ESG
Due Date: November 17 @noon

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Student Name: Aryan Ahadimoghaddam
Student ID: 101066691
Assignment Title: Research Proposition - ESG
Due Date: November 17 @noon