The Nonlinear Impact of ESG on Stock Market Performance among U.S. Manufacturing and Banking Firms

Abstract

Investing according to ESG concerns has become popular and controversial. Companies that score well on ESG concerns may attract socially conscious investors. But do ESG scores collectively and individually impact stock market performance? This paper weighs in on this issue by analyzing the impact that changes in ESG scores have on both the excess stock market returns (alpha) and risk-adjusted returns (Sharpe ratio). We also analyze the differential impact of ESG on financial performance among U.S. manufacturing and banking firms. Using quantile regression analysis, our results show a nonlinear relationship, characterized by a U-shaped and an inverted-U shaped relationship between ESG ratings and alpha and Sharpe ratios respectively. Moreover, we find significant differences regarding the impact of governance, environmental, and social on excess stock market returns in both industries.

JEL Codes: G3, G11, G12, G34

Key words: Environmental, social, governance, stock market returns, ESG, Sharpe ratio

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I. Introduction

Environmental, Social, governance (ESG) investing was first introduced in the late 1960s. At that time ESG investing mainly centered on boycotting products from countries (e.g., South Africa) whose policies were deemed to be abhorrent. Then, around the year 2000 ESG investing switched its focus more to environmental and social concerns. As part of this change, companies have been reporting and advertising their ESG activities to investors.

So, why have companies been so interested in detailing their ESG activities and goals? Are companies simply trying to improve their image to various stakeholders, or are there fundamental value changes that are suggested in environmental, governance, and social scores or measurements? ESG advocates have argued that higher ESG scores lead to less risk and lower costs of capital (Damodoran, 2023). So, if an asset is less risky, then the risk premium should be lower. Damodoran (2023) adds that because it is unclear whether ESG projects lead to lower risk and/or lower cost of financing, then perhaps the primary purpose of ESG is to disclose material issues.

If there is fundamental value in improving a company's ESG score, which part of ESG seems to have the greatest impact on financial value? Do investors place more emphasis on change in ESG ratings among certain kinds of companies versus others? Also, are there increasing or decreasing financial returns to improving ESG ratings? Existing research has addressed the link between ESG investment and corporate financial performance, yet significant gaps persist particularly regarding the relationship between ESG ratings and financial performance, as well as how individual ESG components affect firm value, and differences across industries. This paper

seeks to bridge these research gaps by leveraging the MSCI ESG database on companies from 2013 through 2022 for large manufacturing[1] and banking companies[2]. By employing quantile regression models and multiple response variables, we assess the impact of ESG ratings on corporate financial performance. The hypothesis is that ESG and its subcomponents have a non-linear impact, characterized by both an inverted U and U-shaped relationship with financial performance. To verify the non-linear relationship between ESG and financial performance, this research employs the Sasabuchi-Lind-Mehlum (aka Sasabuchi) test (Lind & Mehlum, 2010; Sasabuchi, 1980). Financial performance is measured by both excess returns or Jensen's alpha (aka alpha) and risk adjusted returns (aka Sharpe ratio). In addition, we hypothesize that there are differences in the optimal ESG investment by industry with environmental projects requiring substantial investment among manufacturing companies, while governance and social investments having a greater influence among banking companies. We do, indeed, find these effects with differences based also on the level of excess returns, industry, and the response variable employed.

This study is unique in using alpha and the Sharpe ratio to measure financial performance. In addition, we use quantile regression analysis to assess the differential effects of ESG and ESG components on financial performance among alpha quartiles. Also, we examine differences between two distinct sectors, manufacturing and banking, whose varying characteristics enable us to disentangle the differential effects of ESG component ratings among these two groups.

II. Literature Review

[1] Manufacturing companies are represented by aerospace and automotive companies.

[2] Service companies are represented by banks.

Much of the research to-date covering the value of ESG investing has focused on the behavior of the investor rather than the firm. That is some investors prefer to invest in companies that have a strong ESG record. However, there has been an active debate whether ESG improvements impact current and / or future firm valuations. Our research delves into three intertwined strands: the financial impact of ESG investments, the potential for non-linear effects of ESG on financial performance, and the varied effects of individual ESG dimensions (Environmental, Social, Governance). We conclude with caveats relating to the research.

IIa. Effect of ESG ratings on financial performance

The relationship between ESG ratings and financial performance can be viewed through different theoretical constructs. Christensen et al. (2022) argues that balancing all parties' or stakeholders' interests enhances corporate value. Similarly, legitimacy theory stresses a social contract between corporations and society, where breaches can lead to reduced consumer demand or increased regulatory pressures. There is also signaling theory, which argues that strong ESG performance reduces financing costs and increases corporate value, (Richardson and Welker, 2001; Plumlee, 2015; Dunn et al., 2018), generally measured by Tobin's Q (MinChung and YongHee, 2014; Wong et al., 2021). Similarly, the resource-based highlights the strategic use of internal resources, such as human capital, a key subcomponent of social, to gain a competitive advantage (Tensie et al, 2021).

Conversely, Azmi et al., 2021, Ahsan and Qureshi, 2021 argue that ESG has a negative impact on financial performance. Their trade-off theory suggests that ESG investments compete for limited resources, potentially increasing operating costs and reducing profitability. Agency theory further critiques ESG investments adding value in proposing that managers may engage in

ESG activities to enhance their own reputations rather than boosting corporate profits; the result may lead to wasted resources and diminished firm value (Miralles-Quiros et al., 2018).

This dynamic is further elaborated by the "too-much-of-a-good-thing" (TMGT) meta-theory proposed by Pierce and Aguinis (2013), whereby, the positive impacts of ESG initiatives can become negative when they exceed a certain threshold, as additional ESG costs surpass their benefits.

Over the past ten years there have been several empirical studies that test these theories, as shown in the following table, which is organized by theory.

Authors (date)	Theory	ESG Data set	Response variable	Results
Christensen et. al (2022)	Stakeholder	Firms worldwide	Absolute CAR	Higher levels of ESG disclosure led to higher stock market volatility and returns
Ahsan and Qureshi, (2021)	Stakeholder	100 best US corporate citizen firms	Tobin's Q	ESG boosts Tobin's Q, but not ROE or ROA
Miralles-Quiros et al., (2018)	Stakeholder theory	-	Book value per share; EPS	Environmental practices are valued by firms not in environmentally sensitive industries.
Koundouri et al. (2022)	Stakeholder	STOXX Europe ESG Leaders 50	Beta; D/E; ROA/ROE	ESG lowers equity risk and boosts ROA/ROE but not in automotive;
Landi and Sciarelli (2019)	Stakeholder	Italian companies	Abnormal returns	ESG has no significant impact on abnormal returns
Wu and Chang 2022	Trade-off	Taiwanese firms	Tobin's Q	ESG has half-convex effect in low-profit firms; concave effect in median /high-profit firms
Azmi et al., 2021	Trade-off	Emerging market banks	Tobin's Q/ ROA	ESG activity boosts bank performance but shows diminishing returns. Environmental-friendly projects boost bank value.
Dunn et al., 2018	Signaling	MSCI World	Book/market, Market cap	Low ESG rated firms have higher risk / betas; Social and governance strongly link to risk;
MinChung and YongHee, 2014	Signaling;	Hospitality sector	ROA and $ROA\ \sigma$	Positive; CSR investments reduce systemic risk in restaurants and casinos but not other segments

Richardson and Welker, 2001	Signaling	Canadian firms	ROE	Positive relationship between social disclosures and the cost of equity
Wong et al., 2021	Signaling	Malaysian firms	Tobin's Q / ROA	ESG ratings reduce cost of capital and increase Tobin's Q

Christensen et. al (2022) use an event study technique to assess how differences in ESG rating changes impact stock market performance. They find that higher levels of ESG disclosure increase disagreements among ratings agencies leading to higher stock market volatility. Similarly, Wu & Chang (2021) find that among the 100 best US corporate citizens (firms), ESG enhances value as measured by Tobin's Q, though the effect on accounting measures, such as ROE and ROA, is less evident. In contrast, Kondor et. al. (2022) found that ESG values do indeed have a positive impact on profitability measures, such as ROE and ROA, and lower the firms stock price volatility or beta. Landi & Sciarelli. (2019), however, in an earlier study found that change in ESG ratings does not impact abnormal returns.

Turning to trade-off theory, Wu and Chang (2021) find that firms with low Tobin's Q will experience diminishing marginal returns to ESG to a greater extent than the firms with higher Tobin's Q. However, in the long run, the returns to ESG investment will increase, causing a U-shaped relationship between ESG and financial returns. Similarly, Azmi et. al. (2021) examine the impact of ESG on bank performance. They find that ESG investments improve cash flow and efficiency but lowers ROE. Their results also show that environmental projects versus investment in social or governance result in higher return. Miralles-Quiros et al. (2018) in an earlier study also found that environmental projects add value, but only to firms in non-environmentally sensitive

industries. In contrast, they find that the market positively values social and government practices in environmentally sensitive industries.

Another strand of the literature views ESG ratings as an information signal of risk and/or value. Dunn et. al (2018) explore this issue and find ESG scores provide information that can change risk estimates; particularly, poor ESG scores portend greater risk. Their study builds on MinChung and YongHee, (2014) study of the hospitality industry; these authors found that ESG ratings lower systemic risk among restaurants and casinos but not in other sectors. Their work builds on Richardson and Welker (2001) who studied the impact of social disclosures and found that releasing social information raises the cost of equity, at least among firms with relatively low return on equity. As a result, they conjecture social disclosure is signaling lower performance and/or higher risk. Wong et. al (2021) also examined the impact of ESG on borrowing cost, but they found that ESG certification lowers the cost of capital and raises a firm's Tobin's Q. Their findings suggest that obtaining ESG certification signals financial value to the firm. Conversely, Lin et al.[3] (2023) caution that ESG investments may not always provide proportional returns, potentially due to increased operational costs, but Kondor et al. (2022) countered that ESG might stabilize returns by reducing investment risk.

IIb Literature Review on the Nonlinear Effects of Variables

Barnett and Salomon (2012) and Lahouel et al. (2022) argue that the discrepancies observed in studies examining the relationship between ESG criteria and financial performance are largely due to nonlinear, curvilinear relationships, indicating a more complex reality than previously understood. Barnett and Salomon (2012) adds that a U-shaped relationship between corporate

[3] Revelli and Viviani (2015) and Landi and Sciarelli (2019) also challenge the direct positive impact of ESG on stock performance

social performance and financial outcomes exists because while initial ESG efforts enhance a firm's reputation and financial gains, overly ambitious efforts may reduce returns due to escalating costs and increasing stakeholder skepticism.

Lahouel et al. (2022) extend this discussion by suggesting that the costs associated with ESG initiatives in stimulating financial performance might follow a U or inverted U shape, depending on the nature of the costs and benefits curves, as depicted in Figures 1a. and 1b below. In figure 1b. Lahouel et. al (2022) shows in Figure 1a that the benefits have diminishing returns, while the costs accelerate, indicative of an inverted U shape curve. In contrast, the relationship may be characterized as a U curve as shown in Figure 1b, whereby the costs are accelerating, while the benefits show a concave or diminishing relationship with financial performance.

Figure1a – Inverted U Curve

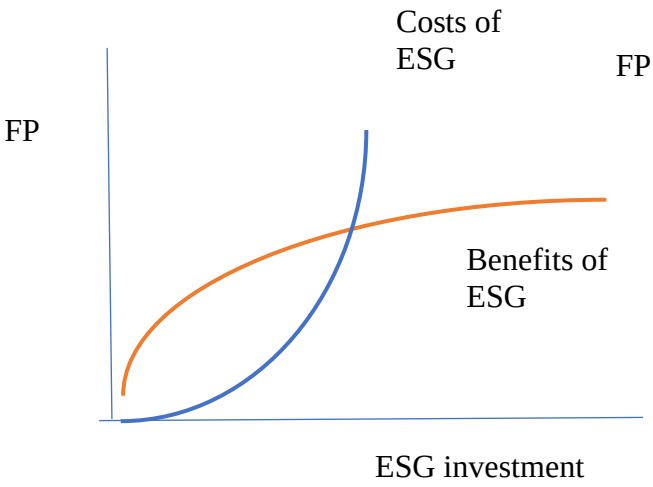
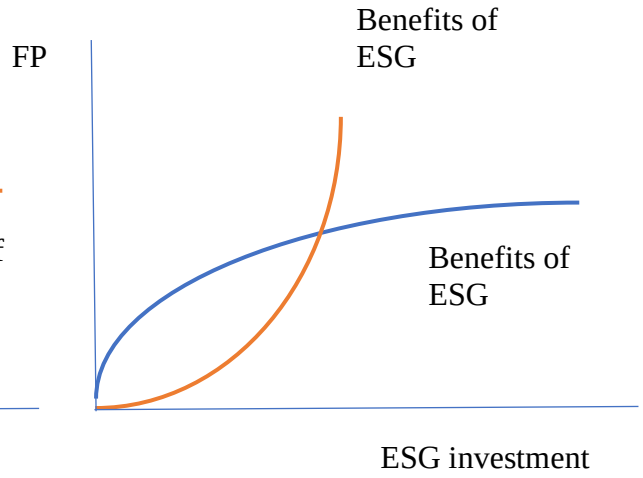


Figure 1b – U curve



These findings were further substantiated by the results of Bagh et. al (2024) who employed a dynamic panel model to test the effects of ESG on the sustainable growth of US and Chinese

companies. Their results showed that there was initially a positive effect but as ESG performance increased beyond a certain threshold the effect on sustainable growth turned negative indicating an inverse U-shaped relationship. Sun et al. (2019) had similar results in an earlier study, but they note the negative effect does not apply to firms with high marketing capabilities. Wu and Chang (2022) also found a concave-convex relationship between ESG and firm valuation but noted the effect differs by financial performance quantile.

Moreover, many[4] of the econometric studies that found an inverted U curve between ESG and financial performance used Tobin's Q or ROA[5] / ROE as the response variable. Still others, such Nuber et al. (2020) and Naimy et al. (2021) have found a U-shaped relationship between ESG and Tobin's Q and/or ROA in their study of German and East Asian markets, respectively. Chen et al. (2018) also found a U-shaped relationship in their study of US companies. Fuente et. al (2022) also found the inverted U-shaped relationship, which they explain by ESG and its components first enhancing value by building trust and mitigating risk, but these firms then experience diminishing returns to risk mitigation.

Our paper builds on these studies by using excess returns and risk adjusted returns to test the impact of ESG and its subcomponents. To our knowledge researchers have not used the excess market return or risk adjusted return as a response variable. In addition, we build on Wu and Chang (2022) methodology by using quantile regression to assess differences in the linear and non-linear effects across the range of the distribution.

IIc. Differences in E, S, and G ratings on Financial Performance

[4] See Buallay et al. (2022) and El Khoury et al. (2023) who have found inverted U-shaped relationships in the tourism sector and banking performance in the MENAT region. Similarly, research in the Chinese market by Pu (2023) confirms the prevalence of inverted U-shaped patterns.

[5] See Lahouel et. al (2022).

Studies by Gompers et al. (2003) and Bebchuk et al. (2013) laid the foundation in exploring the governance dimension, showing that top-tier governance was linked to positive abnormal returns in the 1990s. However, they found minimal effect with the same companies from 2000 to 2008, indicating a maturing market understanding of governance-related profitability. Similarly, Hong and Kacperczyk (2009) noted that companies with low social responsibility scores, or 'sin' companies, often had positive abnormal returns surrounding a rating change, pointing to complex market reactions to different ESG dimensions.

Furthering this research, Nollet et al. (2016) explored both linear and nonlinear relationships between ESG factors and return on capital. They found a negative linear correlation between CSP and return on capital, but a U-shaped relationship in nonlinear models, indicating CSP's positive long-term impact on CFP. The U-shaped relationship was only present, however, between governance and CFP, highlighting governance's crucial role in CSR investments and its influence on the CSP-CFP relationship.

Building on these foundational studies, recent research by La Torre et al. (2020) reveals a statistically significant impact of ESG sub-indexes (environmental, social, governance) on company stock returns, but only in a few industries, like energy and utilities, where ESG investments appear to affect profitability. When considering non-linearity effects of individual ESG components, El Khoury et. al's (2023) study of Middle Eastern financial firms found that governance has a concave relationship in its effect on accounting performance (e.g. ROA), while but a convex relationship with the stock market returns.

Pederson et al. (2021) further explored these impacts through the theory of the ESG-efficient frontier, highlighting that governance typically offered ethical investment opportunities without

compromising returns; he theorizes that robust governance predicts strong future fundamentals. However, environmental and social dimensions proved less reliable as predictors of future value.

Teng et. al (2021) followed up with their study of the impact of ESG risk on corporate sustainable growth (SGR). Using quantile regression, they find that ESG significantly negatively affects SGR, particularly in the in the upper SGR quantiles, suggesting that ESG investments are a drag on profitability among strong performing firms. Furthermore, Teng et. al (2021) find that ESG risk impacts SGR to a greater extent in environmentally sensitive industries.

Most recently, Agarwala et al. (2024) found a U-shaped relationship between the overall ESG score and market performance. Further breakdown of the ESG score showed that while social and governance dimensions exhibit a positive linear relationship with all performance metrics, the environmental dimension displays a U-shaped relationship with market performance. In contrast, Bagh et. al (2024) in their study of US and Chinese firms found that environmental and social ratings exhibit a significant, positive effect on sustainable growth. However, the effect moves from a linear to an inverted U-shaped relationship due to diminishing returns of ESG on growth.

To address these gaps, this study uses quantile regression analysis to assess the nonlinear impact of ESG ratings on companies' quarterly excess returns and risk-adjusted returns within the manufacturing and banking sectors. By studying two different industries, we disentangle the disparate effects of ESG's on financial performance, which will explain some of the conflicting results of other studies regarding the effect of ESG ratings on firm financial performance.

III. Data and Methodology

IIIa. Data description

The data set covers ESG ratings by company for 10 years (2013 to 2022) and includes 53 aerospace and automotive firms (manufacturing companies) and 36 large, banking firms. These companies were included since they all had MSCI scores for some of the ten-year time period and had revenues greater than $1 billion[6].

Monthly ESG ratings were taken from the MSCI database. We converted the monthly data to quarterly to match the company financial data used in our analysis. MSCI data includes monthly weighted ESG ratings, industry adjusted ESG ratings, and separate ratings for environmental, social, and governance by company[7]. In addition, the data set includes ratings for ESG components as shown in table 1.

Table 1: Listing of ESG Components and Subcomponents

ESG components	ESG subcomponent and weight
Environmental[8]	Climate change Natural capital (natural resource) Pollution and waste (waste management) Environmental opportunities
Social[9]	Human capital Product Liability Stakeholder Opposition Social opportunities

[6] We only included larger companies because of the significant stock market volatility with smaller companies.

[7] For each company E, S, and G are weighted based on all the environmental and social key issues as well as the governance pillar score.

[8] Environmental includes 13 issues that are organized into the course subcomponents: climate change, natural capital or resource, pollution and waste, and environmental opportunities. See ESG Ratings Methodology (msci.com) for a list of the 13 items organized into the four subcomponents that comprise the environmental rating.

[9] Social covers health and safety, human capital development, labor management, and supply chain labor standards, which are issues in the human capital subcomponent. Social also covers consumer financial protection, privacy and data security, product safety and quality, and responsible investment, all of which are part of product liability. Lastly, social covers community relations and controversial sources that are part of stakeholder opposition as well as access to health care and opportunities in nutrition and health that are part of social opportunities.

Governance[10]	Corporate governance Corporate behavior

MSCI ratings are determined by analysts who evaluate the level of risk each company faces in the three areas. Information used to arrive at the rating comes from company reports regarding their operations as well as relevant macro-level data. The rating is based on the difference between best practices in the industry and the company's governance, environmental and social policies.

This paper explores how weighted average ESG ratings impacts company value, as determined by excess stock returns and risk adjusted returns. As such, we first needed to calculate and/or estimate the response variables. To do so, we calculated the stock market return as the log difference in returns. We calculate the Sharpe ratio as the average annualized, monthly equity risk premium[11] (monthly return minus the 90-day US treasury bill rate), divided by the average, annualized standard deviation of the monthly equity risk premium.

$$Sharpe\ ratio = \frac{annualized\ monthly\ risk\ premium}{annualized\ monthly\ standard\ deviation\ of\ returns} \quad (1)$$

We then estimated the quarterly alpha per company using the four factor Fama-French rolling regression model to estimate the constant or alpha as shown in equation 3. To do so, we use a window of 31[12] quarters and a rolling regression to estimate the alpha.

[10] Corporate governance covers pay, ownership and control, and accounting, while corporate behavior includes business ethics and tax transparency

[11] To calculate the average, annualized monthly equity risk premium, we take the average risk premium over the prior 12 months, and multiply this amount by 12. The same method was applied to calculating the average, annualized standard deviation. As a result, the first Sharpe Ratio entry for a firm would be in month 13 which covers the average risk premium and standard deviation for the prior 12 months.

[12] 31 quarters were used for the window in the alpha estimation as that is the average number of quarters for each company in the data base. .

$$Return_{it} = \beta_o + \beta_1 EX_{it} + \beta_2 Smb_{it} + \beta_3 Hml_{it} + \beta_4 Mom_{it} + +\epsilon_{it} \quad (2)$$

In this regression return for i, t refers to the stock market return for company i in quarter t. . We then used the Fama-French 4 factor or Carhart (1997) model to estimate stock market returns. Ex refers to the quarterly return on the S&P 500 minus the quarterly 90-day US treasury rate or risk-free rate. Smb is the quarterly return for small minus big companies in the market, while Hml is the quarterly return for high price to book ratios for growth companies minus low price to book ratios for value companies. Finally, momentum is the return for a momentum index[13] for the S&P 500.

After estimating and calculating the response variables, we used quantile regression analysis to estimate how the weighted average ESG rating and each ESG component along with its quadratic form impacts the response variable.

Table 2 shows how the response variables (to include Tobin's Q), weighted ESG and its components, and company financial metrics vary by each alpha quartile.

Table #2: Summary Statistics by Alpha Quartile
Mean and (minimum and maximum)

Alpha (% range)	1st quartile - (0%-25%) n=580	2nd quartile - (26%-50%) n=519	3rd quartile - (51%-75%) n=511	4th quartile (76% to 100%) n=607	Total n=2,219
Annual Alpha	-10.5% (-9.2%, -4.0%)	-3.2% (-24.0%, 0.0%)	0.03% (-8.0%, 12.0)	8.0% (4.0%, 13.6%)	-1.2% (-9.2%, 13.6%)
Annual Sharpe ratio	-0.56 (-24.8, 15.4)	0.11 (-55.5, 32.0)	0.88 (-14.5, 19.8)	0.91 (-22.9, 22.3)	0.14 (-55, 32)

[13] This index is calculated by subtracting the equal weighted average of the lowest performing firms from the equal weighed average of the highest performing firms, lagged one month (Carhart, 1997).

Tobin's Q	0.28 (.04, 2.17)	0.37 (.05, 6.0)	0.62 (.05, 5.6)	1.94 (.07, 17.6)	0.64 (.05, 17.5)
% Banking	0.51 (0, 1)	0.50 (0, 1)	0.42 (0, 1)	0.09 (0, 1)	0.42 (0, 1)
Weight averaged ESG	4.56 (.92, 8)	4.36 (0, 8.6)	3.89 (-.33, 6.6)	3.11 (-1, 6.9)	3.99 (-1, 8.6)
Governance	5.64 (0.4, 52)	8.36 (0.2, 52)	9.42 (0.2, 52)	8.27 (1, 52)	8.35 (0.2, 52)
Environmental	5.67 (0, 29.2)	5.43 (0, 38)	6.43 (0, 38)	5.21 (.23, 38)	5.85 (0, 4, 38)
Social	4.84 (0.3, 39.3)	5.87 (1.2, 40)	6.80 (1.6, 40)	6.65 (0.3, 40)	6.30 (0.3, 40)
Total revenue (in millions of $)	8,880 (0, 57,776)	4,788 (35, 35,687)	4,875 (14.5, 47,292)	3,011 (12.2, 22,130)	4,707 (0, 57,776)
Debt/equity	0.98 (-8.6, 52.5)	0.71 (-12.5, 2.9)	0.26 (-45.3, 15.2)	1.67 (-121, 214)	0.86 (-121, 214)
Intangible assets (in millions of $)	7,633 (0, 56,691)	5,315 (0,80,802)	9,701 (0, 82,205)	7,587 (0,72,191)	6,479 (0, 82,205)

Since table 2 is segmented by alpha quartile, alpha, Sharpe ratio, and Tobin's Q all increase from the 1st to fourth quartile Interestingly, we see that the industry mix is similar for the first three quartiles, the fourth quartile contains only 9% banking, while the other quartiles contain roughly 50% banking. It is also interesting to see that the largest companies by revenue are in the first and second quartile with revenues of approximately $10.5 to 6.7 billion versus approximately $4.3 and $2.2 billion in the other two quartiles.

Regarding ESG ratings, we see a slight decline from the first to the fourth quartile in the weighted ESG rating, suggesting a negative relationship between ESG ratings and alpha. In contrast, we observe an increase in the social rating for each quartile from the first to fourth

quartile. Similarly, the debt-to-equity ratios are higher in the first and second quartile versus the third and fourth quartile. For governance, the lowest rating is in the first quartile; there is no discernable trend in the governance ratings from the second to fourth quartile. Similarly, there is no discernable trend in the environmental ratings between quartiles.

Finally, we see similar debt to equity ratios between quartiles. For intangible assets the highest average amount is in the third quartile.

IIIc. Methodology

To assess the impact of ESG ratings on the financial performance of firms in the aerospace/automotive and banking industries, we used quantile regression analysis after observing the non-linear patterns in the data. In doing so, we tested the following hypotheses.

1. ESG and its subcomponents have a non-linear impact on both alpha and the Sharpe ratio. The non-linear relationship is characterized by both inverted U and U-shaped curves, which vary by alpha quartile.
2. There are differences in the optimal ESG investment by industry. Banking can achieve maximum net financial returns at lower ESG investment levels since financial services are less capital intensive. As such, even modest ESG investments in banking can yield strong financial returns; so, we expect to find a consistent relationship between ESG investments and returns across all quantiles, where typically lower ESG investments result in better returns, while higher ESG amounts lead to diminishing returns, even at higher alpha quantiles.

   In contrast, manufacturing requires higher ESG investment levels (relative to banking) to reach the peak of net financial returns. Thus, we expect in capital-intensive manufacturing, the

effect of ESG investments to differ across financial performance levels. For lower financial performance quantiles (e.g., 1st and 2nd quartiles), firms will initially benefit from ESG investments through efficiency gains or risk reduction. However, as ESG investments rise, operational costs increase, leading to diminishing returns and an inverted U-shaped relationship. However, at higher financial performance quantiles (e.g., 3rd and 4th quartiles), firms may have more resources to support ESG initiatives. As a result, while there may be initial costs, the long-term financial returns to ESG investment improve, resulting in a U-shaped curve where higher ESG investments lead to greater returns. To summarize,

- **Hypothesis 2A:** In **manufacturing**, ESG investments have a diminishing effect on financial returns above a certain threshold in lower financial performance quantiles leading to an inverted U-shaped relationship; in higher quantiles ESG investments have a positive impact on financial returns above a certain threshold, leading to a U-shaped relationship.
- **Hypothesis 2B:** In **banking**, across all financial performance quantiles, ESG investments have a positive impact on financial returns above a certain threshold leading to a U-shaped relationship.

3. Environmental, governance, and social have varying impacts on financial performance in manufacturing and banking. Manufacturing is more sensitive to environmental concerns, while investment in governance and social responsibility management will have a greater effect in the banking sector.

Equations 2 through 5 show the quantile regression model(s) we used to test our hypotheses. There are four equations as we ran models separately for each ESG subcomponent to avoid

multicollinearity. See Table 3a, 3b, and 3c for a correlation matrix[14] for the total sample and both industries.

$$Alpha_{it} = \beta_o + \beta_1 ESG_{it} + \beta_2 {ESG_{it}}^2 + \beta_3 Rev_{it} + \beta_4 D/E_{it} + \beta_5 IntA_{it} + \epsilon_{it}\ , QR \qquad (3)$$

$$Alpha_{it} = \beta_o + \beta_1 G_{it} + \beta_2 {G_{it}}^2 + \beta_3 Rev_{it} + \beta_4 D/E_{it} + \beta_5 IntA_{it} + \epsilon_{it}\ , QR \qquad (4)$$

$$Alpha_{it} = \beta_o + \beta_1 E_{it} + \beta_2 {E_{it}}^2 + \beta_3 Rev_{it} + \beta_4 D/E_{it} + \beta_5 IntA_{it} + \epsilon_{it}\ , QR \qquad (5)$$

$$Alpha_{it} = \beta_o + \beta_1 S_{it} + \beta_2 {S_{it}}^2 + \beta_3 Rev_{it} + \beta_4 D/E_{it} + \beta_5 IntA_{it} + \epsilon_{it}\ , QR \qquad (6)$$

Equations 3 through 6 were run for alpha and also for the Sharpe ratio. In addition, we segmented the sample into manufacturing and banking and showed results for each sector. ESG_{it} refers to the weighted ESG index for company i over quarter t, while G, E, S refer to the government, environmental and social score for company i over quarter t. Weights for the weighted ESG index were predetermined by MSCI. We used the squared variable for ESG, E, S, and G in equations 2 through 5 to account for the non-linearities shown in Figure 2. We also employed the Sasabuchi test statistic[15] to test the validity of the U-shape or inverted U-shape relationship. If the Sasabuchi test statistic confirms a non-linear relationship, we can then assess whether firms are under or overinvesting in ESG and/or the ESG components by comparing the mean ESG or ESG component level to the minimum or maximum in the quartile.

[14] In the banking sector there was some collinearity between intangible assets and revenues.

[15] Refers to a t-statistic that evaluates whether there is a significant difference between two slopes, with one formed from the minimal X point to the minimum point on a curve versus the slope formed from the maximum X point to the minimum point on a curve.

Our methodology follows the approach of Nollet et al. (2016), Fuente et al. (2022) and Wu and Chang (2022) who used a squared term in their modeling of the effect of ESG on firm financial performance. Nollet et al. (2016), identified a U-shaped relationship between ESG and corporate performance, but found this relationship to be solely attributed to the governance component. Fuente el. al (2022), in contrast, found the quadratic relationship to apply to all three variables, while Wu and Chang found the relationship to only apply to environmental and social.

Additionally, we confirmed the presence of a U-shaped (or inverted U-shaped) relationship using the Sasabuchi-Lind-Mehlum (SLM) test (Lind & Mehlum, 2010; Sasabuchi, 1980) alongside Haans et al.'s (2016) three-step testing procedure. For the SLM test to confirm the presence of a U or inverted-U shaped relationship

1 The coefficient β_2 in Equations (3) to (6) must be positive (for a U-shape) or negative (for an inverted U-shape) and statistically significant.

2 Both of the following conditions must hold:

(a) The slope at the lower bound of the ESG value (ESG_{low}), calculated as $\beta_1 + 2 \cdot \beta_2$. $\text{ESG}_{\text{low,}}$ must be significantly less than zero (for a U-shape) or greater than zero (for an inverted U-shape).

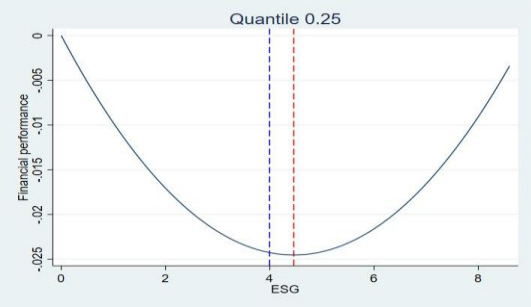
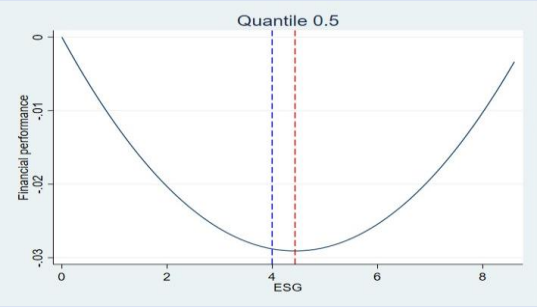
(b) The slope at the upper bound of the ESG value (ESG_{high}), calculated as $\beta_1 + 2 \cdot \beta_2$. ESG_{high} must be significantly greater than zero (for a U -shape) or less than zero (for an inverted U-shape).

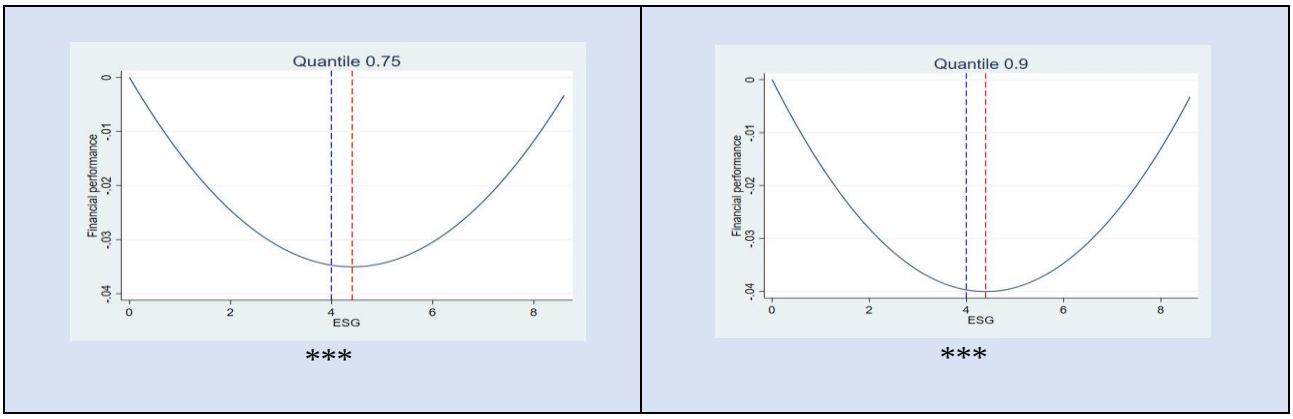
3 The threshold, calculated as $-\beta_1/(2\beta_2)$, must lie within the data range and the Fieller confidence interval $[\hat{C}_{\text{low}}, \hat{C}_{\text{high}}]$ for the threshold lies within the data range.

IV. Results

We first estimate using quantile regression the impact of ESG ratings and ESG subcomponent ratings on the excess stock market return (alpha) and Sharpe ratio. The results using alpha and the Sharpe ratio as the response variables are shown in Tables 4 and 5 respectively. Table 6 shows the quantile regression results by industry using alpha as the response variable. Separate regressions were run for weighted ESG, G, E, and S, with the results separated by a horizontal line in each of the Tables. The results are also shown visually in Figure 2 below, displaying the regression relationship between weighted ESG on financial performance (alpha) by quantile.

Figure 2: Concave–convex Effect and Optimal Value of Weighted ESG Across Quantiles on Alpha

Alpha (25% quantile)	*Alpha (50% quantile)*
 ****	 *****
Alpha (75% quantile)	*Alpha (90% quantile)*

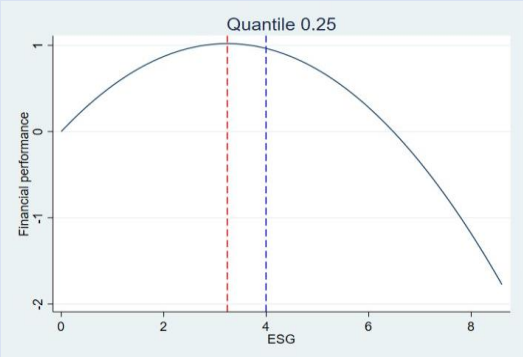
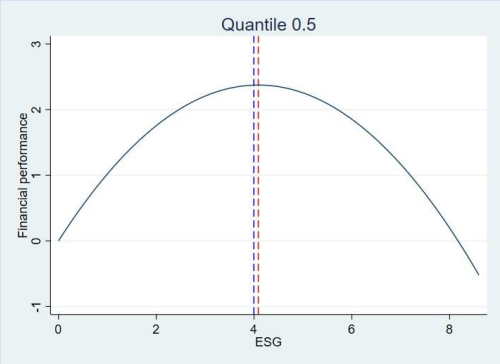


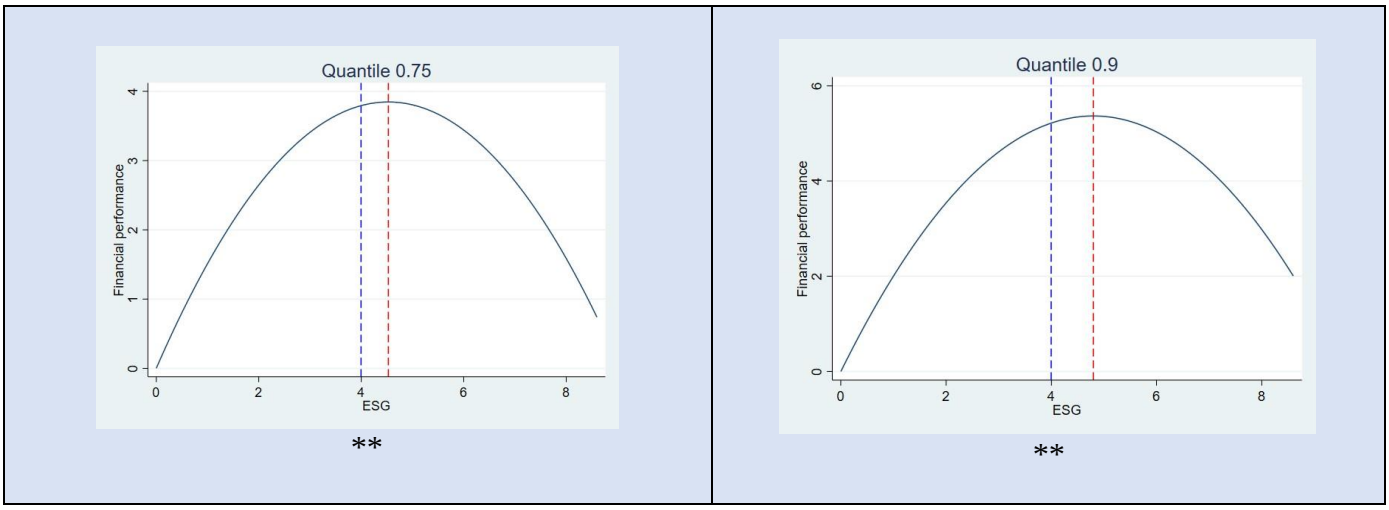
The x-axis represents weighted ESG values, and the y-axis represents financial performance (alpha). The star (s) under the figures indicate the quantile where the Sasabuchi test statistic is significant, meaning that the slopes of the initial and terminal lines are different, indicating a U or inverted-U shape relationship. The red dashed line shows the ESG investment threshold or maximum/minimum level, while the blue dashed line marks the mean ESG rating by quantile. To interpret the results, we assume that ESG ratings are equivalent to investment in ESG or its subcomponent, meaning that a higher/lower rating indicates higher/lower investment.

From the results of Figure 2 and Table 4, it is clear that ESG investment impacts financial returns as shown in the negative, significant coefficients for the linear and quadratic terms and the significant Sasabuchi test statistic in each of the quantiles. We also see in Table 4 that the 95% Fieller interval for the extreme point (extremum) lies inside the specified interval, meaning we can make inferences about the U-shape curve drawn. We also observe that in each of the quantiles the blue lines are just left of the minimum threshold (red line), meaning that firms can either reduce their ESG investment or increase it beyond the threshold to increase financial performance.

Turning to the Sharpe ratio, as shown in Figure 3 below and Table 5, we see that in each of the quantiles for the total sample, the relationship between ESG ratings and financial performance is characterized by an inverted U-shaped relationship. The Sasabuchi test confirms the presence of a non-linear relationship in the 50%, 75%, and 90% quartiles. Thus, when using the Sharpe ratio as the response variable, it seems that ESG investment yields positive risk adjusted returns up to a certain point or threshold. After a certain ESG level, ESG investment actually reduces the Sharpe ratio. We also see in Figure 2 that in the 75% and 90% quartiles, the blue line is left of the red line indicating that firms are under-investing in ESG. For the 50% quartile, the blue and red lines are located at the threshold level suggesting firms in this quartile firms are investing at or near the optimal amount for ESG.

Figure 3: Effect of Weighted ESG Across Quantiles on the Sharpe ratio (Total Sample)

Sharpe Ratio (25% quantile)	Sharpe Ratio (50% quantile)
	 ***
Sharpe Ratio (75% quantile)	Sharpe Ratio (90% quantile)



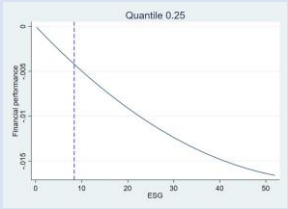
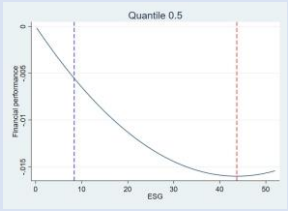
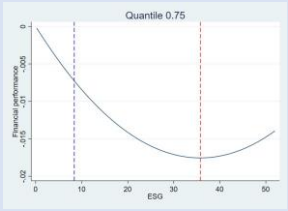
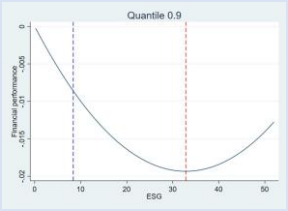
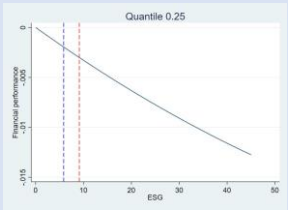
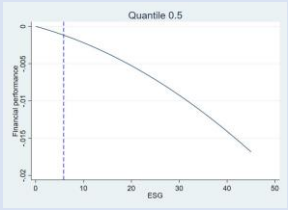
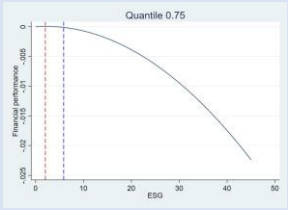
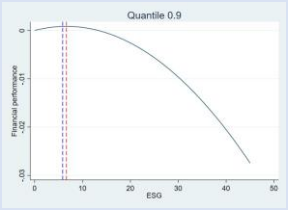
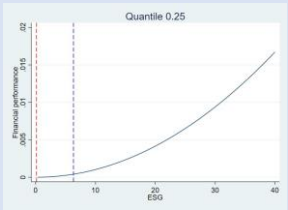
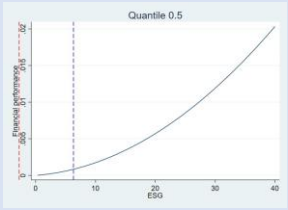
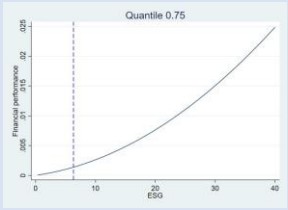
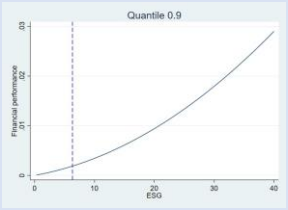
Subcomponents

Moving to the subcomponents, we observe in Figure 4 below that the Sasabuchi test statistic is significant in the 75% and 90% quantile for governance ratings. We also see that the blue line is far left of the red line in these two quantiles, suggesting that firms are investing far less than the minimal threshold, or that there are diminishing returns to investing in governance among the companies with larger excess returns. This half shaped U-shaped relationship appears to be influenced by manufacturing firms (See Figure 5 in the Appendix) where the Sasabuchi statistic is significant at the 10% level in the 75% and 90% quantiles as shown in Table 6 and Figure 5. However, the Fieller interval for the extreme point lies outside the specified interval for these quantiles, which cast doubt on the inferences drawn in the manufacturing industry.

In contrast, the banking industry, also shown in Figure 5, is characterized by a half U-shaped curve showing increasing returns to investing in governance. Accordingly, the blue line is to the right of the red line or minimum threshold, and given the upward slope, it appears banks in the 25%, 50%, and 75% quantiles can invest more in governance to achieve a higher excess return.

Also, the 95% Fieller interval for the extreme point (extremum) lies inside the specified interval for these three quantiles in the banking industry. These findings lend support for hypotheses 2a and 2b.

Figure 4: Effect of ESG Components Across Quantiles on Alpha

	Alpha (25% quantile)	*Alpha (50% quantile)*	*Alpha (75% quantile)*	*Alpha (90% quantile)*
Govt			 ***	 ***
Environ-mental				
Social				

Turning to environmental ratings, we see in Figure 4 and Table 4 that the Sasabuchi test statistic is not significant in the total sample. In addition, neither the linear coefficient nor quadratic coefficient for environmental is significant. However, in Table 6 and Figure 6 in the

Appendix, we see the Sasabuchi test statistic is significant in the banking industry in the 25%, 50%, and 90% quantiles with the Fieller interval for the extreme point (extremum) residing inside the specified interval in the 25% and 50% interval. From Figure 6, we therefore can conclude that the relationship between investing in environmental in the banking industry is characterized by a half inverted U curve, suggesting diminishing returns to investing in environmental programs for banking companies in these quantiles. Furthermore, we see in Figure 6 that the blue line is located just past the red line in the banking industry, suggesting that banking firms in the 25% and 50% quantile are slightly over-investing in environmental programs. The same result applies to the manufacturing industry, in the 50% quantile, in which the curve is characterized by a half U curve with the blue line being far left of the red line. As such manufacturing firms in the 50% quantile are correctly investing far less in environmental programs than the minimum threshold.

Finally, turning to the social rating we see the Sasabuchi test statistic is not significant in either Table 4 or 5 in any of the quantiles. We do see in Table 6 that the Sasabuchi test statistic is significant in the banking industry in the first three quantiles for the social regressions. However, these results are not valid for interpretation as the estimated turning point (extremum) lies outside the specified interval, so inferences cannot be made about the presence of a U or inverted U-shaped relationship.

We do, however, see the coefficient for social to be negative and significant for each of the first three quantiles in Table 5, using the Sharpe ratio. This finding appears to be influenced by the banking industry as shown by the negative, significant social coefficient in the first two quantiles. As such there appears to be diminishing returns to investing in social projects (e.g.

human capital), among the firms, specifically banking firms, with low to medium financial performance.

To summarize, weighted ESG ratings appear to have a non-linear relationship with financial performance, which is characterized by a U-shape curve relative to alpha and an inverted U-shape relationship relative to the Sharpe ratio. Thus, there are conflicting findings based on alpha (excess return) versus the Sharpe ratio (risk adjusted return) as to whether firms with higher financial performance should increase or reduce their ESG investments. This result appears to be driven by governance, where the U-shaped relationship was found to be significant among the higher financial performing firms.

Furthermore, we see that environmental concerns impact both manufacturing and banking companies but the relationship differs with the former characterized by a semi-U curve, suggesting increasing returns, at least in the 50% quantile, and the latter characterized by a semi-inverted U curve across all the quantiles (except for 75). These results are in line with hypotheses 2a and 2b, as in banking, with its lower capital intensity, the optimal threshold for investment in environmental is relatively low. After reaching this threshold, additional investment in environmental projects for banking firms yields limited or even negative returns. In contrast, manufacturing firms, at least in the 50% quantile, need to invest a large amount in environmental projects for there to be financial returns. As such, manufacturing firms in this quantile are investing far less than the threshold.

In addition, we see that consistent in part with hypothesis 3, the social component of ESG primarily impacts banking firms in a linear fashion. This result is only statistically significant in

the lower quantile.

Finally, when we see some consistent patterns for the control variables. First, the coefficient for revenue is negative and significant in both Table 4, and the coefficient for intangible assets is negative and significant in Tables 4 and 5. These results suggest that the smaller companies had better financial performance. Also, overall debt-to-equity did not appear to impact financial returns. However, we did see a negative coefficient for debt-to-equity in the 25, 50%, and 90% quantiles for banking, suggesting that a lower ratio has a positive impact for banking companies on financial returns.

V. Conclusions

This study assesses the impact of ESG ratings on excess stock market returns and risk-adjusted returns among a group of large, U.S. manufacturing and banking companies. The objective is to determine if investing in ESG overall and by ESG component impacts the financial performance of these companies. In our analysis, we looked at linear and non-linear effects and segmented companies by industry.

Our findings indicate a non-linear relationship exists between ESG ratings and financial performance. The relationship is usually, but not always, characterized by a U-shape pattern. Differences emerge in the shape of the relationship with a U-shaped relationship found when alpha is the response variable, versus an inverted U-shaped relationship seen when the Sharpe ratio is the dependent variable. Furthermore, there are differences between industries in how investing in governance and environmental projects impact financial performance. In banking, we see

increasing returns to governance and decreasing returns to environmental projects relative to excess returns. In manufacturing, there are decreasing returns to investing in governance and environmental projects up to a certain threshold, suggesting large investments in these areas are needed to generate a payback for these investments. Finally, social responsibility ratings appear to have a negative, linear effect on financial performance, with the effect found primarily in the banking industry.

This study is unique in several ways. First, we use excess returns (alpha), and the risk adjusted returns (Sharpe ratio) to measure financial performance. In doing so, we look at how ESG ratings impact both returns and risk adjusted returns. In addition, we disentangle the U versus inverted U- shaped relationship between ESG ratings and financial performance. This is done by analyzing the impact of ESG ratings on financial performance (both alpha and the Sharpe ratio) overall, by industry, and by quantile. Third, we use quantile regression analysis to look at the differential, non-linear effects of ESG and ESG components on financial performance.

To summarize, ESG ratings do appear to impact financial performance, but the relationship varies based on stock market returns of the company, the ESG component, and the industry. To build on this study scholars should consider researching the long-term effects of ESG investment and dissecting how various ESG components influence company performance through different economic cycles. Investigating these aspects would substantially enrich the understanding of ESG's role in shaping corporate strategies and investment decision-making processes. We leave it to other research to explore these relationships further and assess how investing in ESG impacts a firm's financial performance.

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Appendix

Table 3a (Correlation Matrix – Total Sample)
(obs=2,110)

	ESG	ESG^2	Gov	Gov^2	Env	Env^2	Soc	Soc^2	Rev	D/E	Int. A
ESG	1.000										
ESG^2	0.963	1.000									
Gov	-0.113	-0.152	1.000								
Gov^2	-0.153	-0.196	0.988	1.000							
Env	-0.051	-0.053	0.790	0.776	1.000						
Env^2	-0.050	-0.073	0.749	0.713	0.934	1.000					
Soc	-0.115	-0.142	0.925	0.923	0.730	0.680	1.000				
Soc^2	-0.146	-0.181	0.887	0.882	0.640	0.573	0.972	1.000			
Revenue	-0.014	-0.010	-0.097	-0.073	0.081	-0.025	-0.098	-0.069	1.000		
Debt/Equi	-0.003	-0.012	-0.018	-0.014	-0.005	-0.011	-0.014	-0.013	0.035	1.000	
Int. Ass	-0.011	-0.029	-0.046	-0.033	-0.049	-0.017	-0.029	-0.024	-0.410	-0.005	1.000

Table 3b (Correlation Matrix – Aerospace/automotive sample)
(obs=1,236)

	ESG	ESG^2	Gov	Gov^2	Env	Env^2	Soc	Soc^2	Rev	D/E	Int. A
ESG	1.00										
ESG^2	0.96	1.00									
Gov	-0.08	-0.15	1.00								
Gov^2	-0.10	-0.17	0.99	1.00							
Env	-0.03	-0.06	0.87	0.85	1.00						
Env^2	-0.01	-0.05	0.75	0.72	0.97	1.00					
Soc	-0.07	-0.13	0.94	0.93	0.75	0.67	1.00				
Soc^2	-0.10	-0.16	0.88	0.86	0.66	0.56	0.97	1.00			
Revenue	-0.02	-0.04	-0.06	-0.05	-0.02	-0.05	-0.11	-0.05	1.00		
Debt/Equi	0.01	0.01	0.17	0.02	-0.01	-0.01	-0.01	-0.02	0.05	1.00	
Int. Ass	-0.04	-0.05	0.28	-0.01	-0.04	-0.04	-0.01	-0.01	0.11	-0.04	1.00

Table3c (Correlation Matrix – Banking sample)
(obs=874)

	ESG	ESG^2	Gov	Gov^2	Env	Env^2	Soc	Soc^2	Rev	D/E	IntA
ESG	1.00										
ESG^2	0.99	1.00									
Gov	0.45	0.41	1.00								
Gov^2	0.42	0.38	0.97	1.00							
Env	0.31	0.32	-0.38	-0.05	1.00						
Env^2	0.27	0.28	-0.35	-0.07	0.97	1.00					
Soc	0.76	0.77	-0.13	-0.09	0.40	0.35	1.00				
Soc^2	0.75	0.78	-0.13	-0.09	0.40	0.35	0.99	1.00			
Revenue	-0.10	-0.10	-0.52	-0.35	0.52	0.49	0.013	0.12	1.00		
Debt/Equi	-0.03	-0.02	-0.12	-0.16	0.02	-0.01	0.01	0.02	0.09	1.00	
Int. Ass	-0.04	-0.04	-0.50	-0.23	0.47	0.44	0.20	0.18	0.74	0.10	1.00

Figure 5 - Alpha Plotted Across Quantiles for Governance Ratings in both Industries

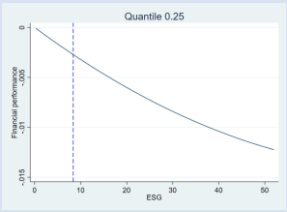
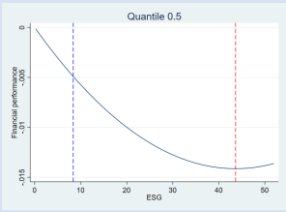
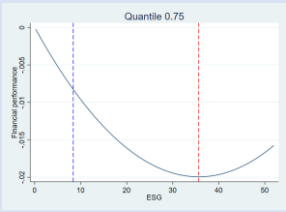
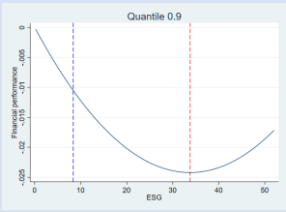
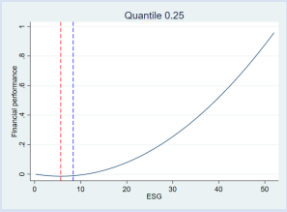
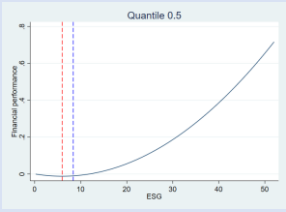
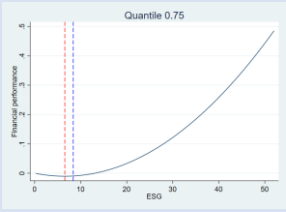
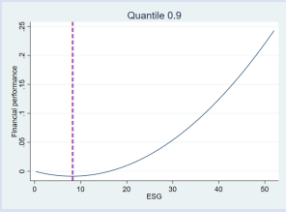
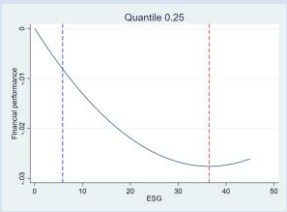
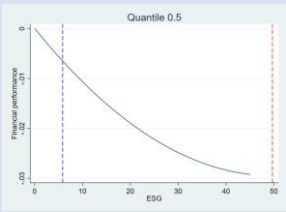
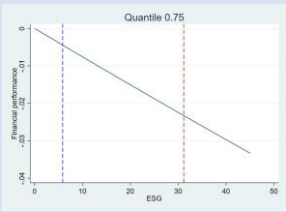
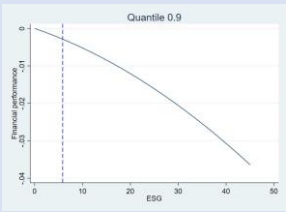
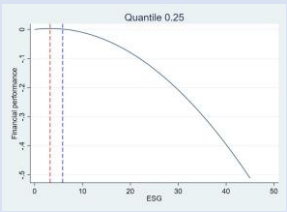
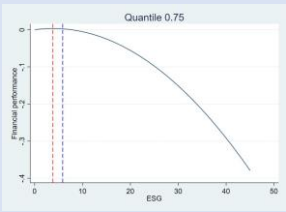
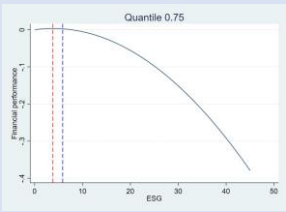
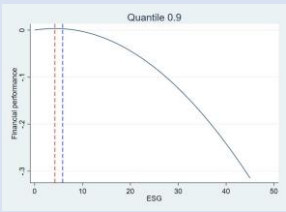
	Alpha (25% quantile)	*Alpha (50% quantile)*	*Alpha (75% quantile)*	*Alpha (90% quantile)*
Manufacturing			 *	 *
Banking	 ***	 ***	 ***	

Figure 6 - Alpha Plotted Across Quantiles for Environmental Ratings in both Industries

	Alpha (25% quantile)	*Alpha (50% quantile)*	*Alpha (75% quantile)*	*Alpha (90% quantile)*
Manufacturing		 ***		
Banking				

	***	***		***

Table 4: Effect of ESG Ratings on Alpha - Quantile Regression

Variable	25% Alpha	50% Alpha6	75% Alpha	90% Alpha
ESG	**-0.010*** **	**-0.013*** **	**-0.015*** **	**-0.017*** **
	(0.00)	**(0.00)**	**(0.00)**	**(0.01)**
ESG-squared	**0.001****	**0.001****	**0.002****	**0.002****
	(0.00)	(0.00)	(0.00)	(0.00)
Total revenue	**-3.30e-07*** **	**-3.13e-07*** **	**-2.90e-07*** **	**-2.71e-07****
	(0.00)	(0.00)	(0.00)	(0.00)
Debt/equity	2.70E-05	-1.06E-05	-6.11E-05	-0.000104
	(0.00)	(0.00)	(0.00)	(0.00)
Intangible assets	**-1.05e-06*** **	**-7.38e-07*** **	**-3.19E-07**	**3.83E-08**
	(0.00)	(0.00)	(0.00)	(0.00)
Slope - low end)	**-0.011****	**-0.0131*** **	**-.0159*** **	**-.0182*** **
Slope - high end	**.0102****	**0.012*** **	**.0151*** **	**0.017*** **
Sasabuchi test statistic	**2.16****	**0.0123*** **	**2.99*** **	**2.46*** **
Threshold (−β1 / (2 β2)/within data range	4.460/Yes	4.432/Yes	4.406/Yes	4.391/Yes
95% Fieller interval for extreme point	[3.942; 6.945]	[4.054; 5.323]	[4.017; 5.363]	[3.930; 5.924]
Gov	-0.001	**-0.001***	**-0.001***	**-0.001***
	(0.00)	(0.00)	(0.00)	(0.00)
Gov-squared	4.22E-06	**8.36e-06***	**1.37e-05****	**1.79e-05****
	(0.00)	(0.00)	(0.00)	(0.00)
Total revenue	**-3.53e-07*** **	**-3.39e-07*** **	**-3.22e-07*** **	**-3.08e-07****
	(0.00)	(0.00)	(0.00)	(0.00)
Debt/equity	2.95E-05	-9.65E-06	-5.99E-05	-0.0001
	(0.00)	(0.00)	(0.00)	(0.00)
Intangible assets	**-1.08e-06*** **	**-7.54e-07*** **	-3.38E-07	-6.99E-09
	(0.00)	(0.00)	(0.00)	(0.00)
Slope - low end)	-	-0.001**	**-0.001****	**-0.001****
Slope - high end	-	0.000	**0.000***	**.001****
Sasabuchi test statistic	-	0.580	**1.5***	**1.66****
Threshold (−β1 / (2 β2)/within data range	-	43.694/Yes	35.77/Yes	32.832/Yes
95% Fieller interval for extreme point	-	[-Inf; +Inf]	[8.534; 70.308]	[-22.890; 66.034]
Env	0.000	0.000	0.000	0.000
	(0.00)	(0.00)	(0.00)	(0.00)
Env-squared	1.29E-06	-4.43E-06	-1.21E-05	-1.92E-05
	(0.00)	(0.00)	(0.00)	(0.00)
Total revenue	**-3.59e-07*** **	**-3.47e-07*** **	**-3.32e-07*** **	**-3.17e-07****
	(0.00)	(0.00)	(0.00)	(0.00)
Debt/equity	2.65E-05	-1.00E-05	-5.93E-05	-0.000104
	(0.00)	(0.00)	(0.00)	(0.00)
Intangible assets	**-1.10e-06*** **	**-7.98e-07*** **	-3.91E-07	-1.83E-08
	(0.00)	(0.00)	(0.00)	(0.00)
Slope - low end)	-	-	0.000	0.000
Slope - high end	-	-	-.001***	-.001***

Sasabuchi test statistic	-	-	0.120	0.430
Threshold (−β1 / (2 β2)/within data range	-	-	2.016/Yes	6.62/Yes
95% Fieller interval for extreme point	-	-	[-Inf;79.457] U [16.422;+Inf]	[-Inf;88.345] U [18.379;+Inf]
Social	2.72E-06	7.19E-05	0.000	0.000
	(0.00)	(0.00)	(0.00)	(0.00)
Social-squared	1.04E-05	1.10E-05	1.17E-05	1.24E-05
	(0.00)	(0.00)	(0.00)	(0.00)
Total revenue	**-3.60e-07*** **	**-3.49e-07*** **	**-3.36e-07*** **	**-3.23e-07** **
	(0.00)	(0.00)	(0.00)	(0.00)
Debt/equity	2.70E-05	-1.10E-05	-5.89E-05	-0.000103
	(0.00)	(0.00)	(0.00)	(0.00)
Intangible assets	**-1.18e-06*** **	**-8.49e-07*** **	-4.29E-07	-4.30E-08
	(0.00)	(0.00)	(0.00)	(0.00)
Slope - low end)	0	-	-	-
Slope - high end	0.001***	-	-	-
Sasabuchi test statistic	0.000	-	-	-
Threshold (−β1 / (2 β2)/within data range	0.124/Yes	-	-	-
95% Fieller interval for extreme point	[-Inf;57.177646] U [22.133068;+Inf]	-	-	-
Observations	2,110	2,110	2,110	2,110

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 5: Effect of ESG Ratings on Sharpe Ratios - Quantile Regression

VARIABLES	25% Sharpe	50% Sharpe	75% Sharpe	90% Sharpe
ESG	0.632	**1.175*** **	**1.747*** **	**2.316*** **
	(0.53)	(0.41)	(0.53)	(0.80)
ESG-squared	-0.0955	**-0.143*** **	**-0.193*** **	**-0.243** **
	(0.06)	(0.05)	(0.06)	(0.09)
Total revenue	-1E-05	-1E-05	-8E-06	-6E-06
	(0.00)	(0.00)	(0.00)	(0.00)
Debt/equity	0.001	-0.003	-0.007	-0.010
	(0.01)	(0.01)	(0.01)	(0.01)
Intangible assets	**-8.26e-05*** **	**-7.40e-05*** **	**-6.50e-05** **	-5.60E-05
	(0.00)	(0.00)	(0.00)	(0.00)
Slope - low end	0.630	1.162***	1.699***	2.236**
Slope - high end	-1.043**	-1.284***	-1.527**	-1.770**
Sasabuchi test statistic	1.250	2.59***	2.16**	1.69**
Threshold (−β1 / (2 β2)/within data range	3.238/Yes	4.086/Yes	4.529/Yes	4.7980/Yes
95% Fieller interval for extreme point	[-Inf;8.502] U [4.010;+Inf]	[3.211; 4.771]	[3.902; 6.661]	[4.092; 43.893]
Gov	**-0.128*** **	**-0.067** *	0.003	0.071
	(0.05)	(0.04)	(0.05)	(0.07)
Gov-squared	0.001	0.000	**-0.001** **	**-0.002** **
	(0.00)	(0.00)	(0.00)	(0.00)
Total revenue	-9.85E-06	-8.90E-06	-7.82E-06	-6.77E-06
	(0.00)	(0.00)	(0.00)	(0.00)
Debt/equity	0.001	-0.002	-0.006	-0.010
	(0.01)	(0.01)	(0.01)	(0.01)
Intangible assets	-7.88e-05***	-7.31e-05***	-6.67e-05***	-6.04E-05
	(0.00)	(0.00)	(0.00)	(0.00)
Slope - low end	-	-	0.008	0.075
Slope - high end	-	-	-.151***	-0.186***
Sasabuchi test statistic	-	-	0.160	1.020
Threshold (−β1 / (2 β2)/within data range	-	-	2.644	14.899/Yes
95% Fieller interval for extreme point	-	-	[-326.888; 22.872]	[-59.063; 33.592]
Env	0.045	**0.0806** *	**0.122** **	**0.164** *
	(0.05)	(0.04)	(0.06)	(0.09)
Env-squared	0.002	0.001	0.000	-0.001
	(0.00)	(0.00)	(0.00)	(0.00)
Total revenue	-1.01E-05	-8.23E-06	-5.99E-06	-3.75E-06
	(0.00)	(0.00)	(0.00)	(0.00)
Debt/equity	0.001	-0.002	-0.006	-0.010
	(0.01)	(0.01)	(0.01)	(0.01)
Intangible assets	-6.40e-05***	-6.07e-05***	-5.69e-05**	0.000
	(0.00)	(0.00)	(0.00)	(0.00)
Slope - low end	-	-	-	-
Slope - high end	-	-	-	-
Sasabuchi test statistic	-	-	-	-

Threshold (−β1 / (2 β2)/within data range	-	-	-	-
95% Fieller interval for extreme point	-	-	-	-
Soc	**-0.191*** **	**-0.182*** **	**-0.172*** **	-0.162
	(0.06)	(0.05)	(0.07)	(0.10)
Soc-squared	**0.002** **	**0.002** **	**0.002** *	0.002
	(0.00)	(0.00)	(0.00)	(0.00)
Total revenue	-8.81E-06	-6.67E-06	-4.25E-06	-1.86E-06
	(0.00)	(0.00)	(0.00)	(0.00)
Debt/equity	0.002	-0.002	-0.006	-0.010
	(0.01)	(0.01)	(0.01)	(0.01)
Intangible assets	**-6.97e-05*** **	**-6.57e-05*** **	**-6.12e-05** **	-5.67E-05
	(0.00)	(0.00)	(0.00)	(0.00)
Slope - low end	-	-	-	-
Slope - high end	-	-	-	-
Sasabuchi test statistic	-	-	-	-
Threshold (−β1 / (2 β2)/within data range	-	-	-	-
95% Fieller interval for extreme point	-	-	-	-
Observations	1,698	1,698	1,698	1,698

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 6: Effect of ESG Ratings on Alpha by Industry – Quantile Regression

VARIABLES	25% Mfg. alpha	25% Banking alpha	50% Mfg. alpha	50% Banking alpha	75% Mfg. alpha	75% Banking alpha	90% Mfg. alpha	90% Banking alpha
ESG	**-0.012** **	-0.004	**-0.013*** **	**-0.005** **	**-0.006** **	**-0.016*** **	**-0.019*** **	**-0.008** *
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)
ESG-squared	**0.001** **	0.000	**0.002*** **	0.000	0.000	**0.002*** **	**0.002** **	0.001
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Total revenue	**-1.57e-06*** **	**-1.52e-07** **	**-1.53e-06*** **	**-1.30e-07*** **	**-1.07e-07** *	**-1.47e-06*** **	**-1.43e-06** **	0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Debt/equity	0.000	**-0.002** **	0.000	**-0.003*** **	**-0.003*** **	0.000	0.000	**-0.004*** **
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Intangible assets	**-2.04e-06*** **	0.000	**-1.58e-06*** **	**2.08e-07** *	**3.39e-07*** **	**-8.98e-07** *	0.000	**4.67e-07** **
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Slope – low end	-.0123***	-	-.0146***	-0.005**	-.0179***	-.007***	-0.020***	-0.008**
Slope – high end	0.013**	-	.0152**	0.000	0.018***	0.001	0.02**	0.003
Sasabuchi test statisti	2.1**	-	2.94**	0.040	2.63***	0.510	2.14**	0.670
Threshold (−β1 / (2 β2	4.178/Yes	-	4.211/Yes	8.44/Yes	4.243/Yes	7.019/Yes	4.260/Yes	6.307/Ye
95% Fieller interval	[3.384; 7.040]	-	[3.684; 5.257]	[-Inf;5.672] U [-2.066;+Inf]	[3.658; 5.607]	[-Inf;5.238] U [-3.267;+Inf]	[3.528; 6.919]	[-Inf;4.802] [.374;+Inf]
Gov	0.000	**-0.005*** **	**-0.001**	**-0.004*** **	**-0.003*** **	-0.001	-0.001	**-0.002** **
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Gov-squared	0.000	**0.0004*** **	0.000	**0.0003*** **	**0.0002*** **	0.000	0.000	0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
total revenue	**-1.71e-06*** **	**-1.24e-07** **	**-1.71e-06*** **	**-1.19e-07*** **	**-1.15e-07** **	**-1.70e-06*** **	**0.000*** **	0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
debt/equity	3.79E-05	**-0.002** *	1.29E-05	**-0.002*** **	**-0.003*** **	0.000	0.000	**-0.004*** **
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

intangible assets	**-2.00e-06*** **	2.87E-08	**-1.57e-06*** **	1.26E-07	**2.19e-07***	**-8.94e-07***	-4.36E-07	**3.17e-07***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Slope – low end	-	**-0.005*** **	-0.001	**-0.004*** **	**-0.001***	**-.003*** **	**-.001***	(0.00)
Slope – high end	-	**0.042*** **	0.000	**0.032*** **	**.001***	**0.022*** **	**.001***	-.002**
Sasabuchi test statisti	-	**6.59*** **	0.410	**6.06*** **	**1.36***	**3.5*** **	**1.28***	0.011
Threshold (−β1 / (2 β		5.664/Yes	43.650/Yes	5.979/Yes	35.642/Yes	6.546/Yes	33.769/Yes	8.116/Yes
95% Fieller interval	-	[5.103; 6.319]	[-Inf; +Inf]	[5.383; 6.762]	[-Inf; +Inf]	[5.492; 8.750]	[-Inf; +Inf]	-Inf;5.343] U [-.292;+Inf]
Env	**-0.002*** **	**0.002*** **	**-0.001*** **	**0.002*** **	**0.002*** **	-0.001	0.000	**0.002***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Env-squared	0.000	**-0.0003*** **	0.000	**-0.000*** **	**-0.000*** **	0.000	0.000	**-0.000*** **
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Total revenue	**-1.75e-06*** **	**-1.58e-07*** **	**-1.76e-06*** **	**-1.50e-07*** **	**-1.38e-07*** **	**-1.77e-06*** **	**-1.77e-06*** **	0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Debt/equity	3.89E-05	**-0.00213*** **	9.84E-06	**-0.003*** **	**-0.003*** **	-2.76E-05	-5.63E-05	**-0.004*** **
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Intangible assets	**-2.27e-06*** **	**3.19e-07*** **	**-1.77e-06*** **	**3.62e-07*** **	**4.22e-07*** **	**-1.14e-06*** **	0.000	**4.72e-07*** **
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Slope – low end	-.002**	0.002***	-	0.002***	0.002***	-	-	0.002**
Slope – high end	0.000	-.0246***	-	-0.022***	-.0186***	-	-	-.0156**
Sasabuchi test statisti	0.630	**2.96*** **	-	**3.56*** **	**2.75*** **	-	-	**1.83***
Threshold (−β1 / (2 β	36.460	3.215/Yes	-	3.421/Yes	3.789/Yes	-	-	4.216/Yes
95% Fieller interval	[-Inf;27.933] [-4.664;+Inf	[1.759; 4.0989]	-	[2.289; 4.201]	[2.080; 4.938]	-	-	[-2.747; 8.455]
Social	0.000	**-0.004*** **	0.000	**-0.004*** **	-0.003	0.000	0.001	-0.002
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Social-squared	0.000	**0.0005***	0.000	**0.0004*** **	0.000	0.000	0.000	0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Total revenue	**-1.74e-06*** **	**-1.62e-07*** **	**-1.73e-06*** **	**-1.39e-07*** **	**-1.19e-07*** **	**-1.73e-06*** **	**-1.72e-06*** **	0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Debt/equity	0.000	**-0.003*** **	0.000	**-0.003*** **	**-0.003*** **	0.000	0.000	**-0.004*** **
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Intangible assets	**-2.31e-06*** **	0.000	**-1.80e-06*** **	0.000	**3.00e-07*** **	**-1.16e-06*** **	0.000	**4.36e-07*** **
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Slope – low end	-.002**	-.004**	-	-0.004**	-	-.003*	-	-0.002
Slope – high end	0.000	0.032**	-	.0251**	-	0.019*	-	0.011
Sasabuchi test statistic	0.630	**1.86*** **	-	**1.96*** **	-	**1.3***	-	0.530
Threshold (−β1 / (2 β	36.460	4.735/Yes		4.962/Yes		5.3/Yes		6.147/Yes
95% Fieller interval	[-Inf;27.933] 4.664;+In	[-Inf;2.324] U [-1.288;+Inf		[3.763; 46.321]		[-Inf; +Inf]		[-Inf; +Inf]
Observations	1,248	874	1,248	874	874	1,248	1,248	874

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1