How Do ESG Performance and Awareness Affect Firm Value and Corporate Overinvestment?†

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Abstract

The relationship between a firm's environmental, social, and governance (ESG) performance and its firm value has attracted considerable attention due to the rapid growth of ESG investing over the past decade. This study examines how ESG performance affects firm value, proxied by Tobin's Q, whilst also exploring whether investor awareness of ESG activities have an impact on this relationship. The results indicate that as global ESG awareness, measured by the number of signatories to the United Nations Principles for Responsible Investment (PRI), increases, firms with higher ESG performance tend to be valued higher. Regarding corporate investment, the results suggest that firms with better ESG performance have larger investment opportunities, reflected in higher Tobin's Q. Building on these findings, the study further investigates

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whether firms with higher ESG performance are more prone to overinvest. The overall results provide little evidence that ESG performance induces the firms' overinvestment behavior for most of the sectors.

Keywords: Environmental, Social, Governance, Controversies, Tobin's Q, Overinvestment

JEL Codes: D25, G30, G32

1 Introduction

Over the last decade, there has been an increasing interest in environmental, social, and governance (ESG) investing, which refers to a class of investing also known as "sustainable investing." Consequently, investments have expanded significantly over the past 10 years. For example, as of March 2024, the number of signatories of the United Nations Principles of Responsible Investment (PRI) has exceeded 5,300 among institutional investors, more than quadrupling over the last decade. In addition, the total assets under management of the PRI signatories exceeded 120 trillion US dollars in 2023, representing nearly a sixfold growth since 2010. These trends provide compelling evidence that many asset owners are looking to increase investments that generate positive social and environmental impacts in order to pursue long-term investment performance.

One natural question related to ESG investment is whether investing in high-ESG-characteristic firms improves overall portfolio performance. Similarly, it is equally instructive to investigate whether higher ESG performance translates into greater firm values. As reviewed in the next section, a growing body of literature reports a positive association between ESG performance and firm value. Nevertheless, few studies have explored the role of ESG awareness in shaping this relationship. The first objective of this study is to provide new empirical evidence on this issue by analyzing how ESG performance affects firm value, proxied by Tobin's Q, whilst also exploring whether investor awareness of ESG activities have an impact on this relationship. In addition, we investigate which ESG pillar(s) have a greater impact on firm value across different industry sectors.

Regarding corporate investment, higher firm values, as reflected in a higher Tobin's Q, could provide firms with larger investment opportunities. Consequently, if better ESG performance is associated with higher firm value, it could be inferred that firms with stronger ESG performance may enjoy more extensive investment opportunities. Another dimension of the relationship between investments and ESG scores is that firms may need to undertake substantial investments to achieve and maintain high ESG scores, as discussed by, among others, Duque-Grisales and Aguilera-Caracuel (2019). This suggests that firms with higher ESG scores may tend to invest beyond the expected level implied by economic fundamentals, which is referred to as overinvestment in this paper, following the definition in Richardson (2006), and discussed more formally later. Therefore, higher ESG scores could have two opposing impacts on overinvestment. On the one hand, higher ESG scores could

reduce overinvestment by giving firms broader investment opportunities. On the other hand, achieving and maintaining high ESG scores may require firms to overinvest, as firms need additional effort to enhance ESG engagements. The second objective of this study is to examine whether there is a relationship between ESG scores and firms' overinvestment behavior. Furthermore, if such a relationship exists, it is also instructive to investigate which ESG pillar(s) are more closely associated with overinvestment. In addressing these questions, we also consider the potential moderating role of increasing ESG awareness.

This study contributes to the current strand of literature in three ways. First, it deepens the understanding of the relationship between ESG scores and firm value. While many previous studies have documented a positive relationship between ESG scores and firm value, this study sheds light on additional aspects of this literature by identifying which ESG pillar(s) have a more pronounced impact across different sectors. Furthermore, the study examines how increasing global ESG awareness, proxied by the number of PRI signatories, affects this relationship, offering insights into how external investor attention shapes the valuation effects of ESG performance. Second, it explores the link between ESG and corporate investment decisions. Although numerous studies have focused on the valuation effects of ESG performance, relatively few studies discuss the firms' investment decisions in relation to their ESG performance. This study addresses this gap by providing a comprehensive analysis of how firms' ESG performance may affect their investment decision-making. Third, this study extends the overinvestment literature. Prior research, including Richardson (2006), Wei et al. (2019), and Irawan and Okimoto (2020), has primarily focused on the roles of economic conditions and firms' internal financial factors in driving overinvestment. By contrast, this study empirically investigates the relationship between ESG performance and overinvestment behavior, while the potential moderating effect of increasing ESG awareness on this relationship. Together, these three contributions highlight the importance of this research.

To this end, three analyzes are performed in this study. The first analysis examines the relationship between ESG scores and firm values measured by Tobin's Q. The second analysis focuses on overinvestment by implementing the framework of Richardson (2006) to identify over- and underinvestment among firms in the sample. The third analysis investigates the relationship between ESG scores and overinvestment. For this analysis, the framework of Irawan and Okimoto (2020) is adopted and extended.

This study has several key findings. The first analysis reveals a positive relationship between ESG performance and awareness, and firm values (Tobin's Q) across many sectors.

In particular, the results indicate that as ESG awareness increases, firms with stronger ESG performance are valued higher. The second analysis highlights the vital role of firms' internal financial factors in shaping investment decisions. More importantly, the results confirm that Tobin's Q is positively associated with firms' investment, suggesting that firms with higher market valuation tend to have greater investment opportunities. Finally, the third analysis finds little evidence that ESG performance leads to overinvestment behavior in most sectors.

The remainder of this paper proceeds as follows. Section 2 reviews a block of literature fundamental to this study. Section 3 discusses the dataset, and Section 4 details the methods implemented for the three analyzes. Section 5 lists the empirical results and discusses them in the context of the current literature strand. Finally, Section 6 concludes the paper.

2 Literature Review

2.1 ESG Performance and Market Value

Literature discussing the relationship between ESG performance and firm value is emerging. The majority have found a positive relationship between ESG performance and firm value. For example, Hartzmark and Sussman (2019) provide strong evidence that investors attract value sustainability. Specifically, they found that sustainability warrants a better future performance. Aligned with this, Li et al. (2018) find that ESG report disclosure positively affects firm value. Many other studies, such as Wong et al. (2020), Fatemi et al. (2018), Mervelskemper and Streit (2017), and Dimson et al. (2015), also find similar results. In addition, Auer (2016) finds that excluding firms with bad ESG performance or unrated performance does not negatively affect the overall portfolio performance. However, Duque-Grisales and Aguilera-Caracuel (2019) find that the relationship is significantly negative for firms in Latin countries.

Regarding ESG sub-indices, Aouadi and Marsat (2018) find that ESG controversies score does not directly affect firm value; however, its interactions with other variables have a significant and positive impact. Li et al. (2019) document that firms tend to engage only in symbolic instead of substantive CSR activities, and this tendency, combined with a low level of controversies, positively influences market value. Similarly, Nirino et al. (2021) document a positive relationship between controversies score and market value.

Furthermore, many studies explore the relationship between corporate social responsibility (CSR), a component of the ESG score, and firm value. Lins et al. (2017) find that

firms with high CSR scores exhibit higher stock returns, profitability, growth, and sales per employee. Ferrell et al. (2016) also identify a significantly positive link between CSR performance and firm value. Conversely, Krüger (2015) find that while positive CSR-related news resonates negatively (though to a weak extent) with investors due to agency problems, negative CSR news elicits a strong negative market reaction.

This study examines both the impact of ESG on firm value and the influence of firm value on investment behavior, using Tobin's Q as a common indicator. Tobin's Q is an extremely popular measure of a firm's market value and has been employed in numerous studies, including Wong et al. (2020), Fatemi et al. (2018), Aouadi and Marsat (2018), Li et al. (2018), and Dimson et al. (2015). Given its relevance to investment decisions, Tobin's Q is more suitable for this study than alternative measures such as PBR or PER.

2.2 Market Value and Corporate Investment

The fundamental principle of the Q-theory of corporate investment argues that firms with high Tobin's Q will have a larger investment opportunity, as they have greater access to funding in the form of either equity or debt issuance. This is because if the market perceives a firm's planned investment as profitable, its share price will tend to rise (Tobin (1969), Tobin and Brainard (1976), Yoshikawa (1980), Hayashi (1982), Abel and Eberly (1994)). However, Chirinko (1993) highlights the weak empirical performance of the Q theory, prompting subsequent studies such as Barnett and Sakellaris (1999), Kalyvitis (2006), and Abel and Eberly (2011) to refine and improve its empirical validity. In this study, the theory underscores a strong nexus between market value and investment behavior, suggesting that firms with higher Q tend to invest more.

Empirically, many studies document the relationship between market value and corporate investment. Foucault and Fresard (2014) find that peer valuation is significantly related to a firm's investment decision. Asker et al. (2015) find that short-termism tendency puts pressure and distorts investment decisions of publicly-listed firms. Their results show that publicly listed firms are less responsive to investment opportunities and, in general, invest less.

Furthermore, Cao et al. (2019) find that financial frictions weaken the relationship between Q and investment. Lin et al. (2018) find that interest rate explains the relationship between Q and investment. Chalak and Kim (2020) study the role of Tobin's Q as a proxy of

marginal q in affecting firms' investment, saving, and debt. Furthermore, Jinji et al. (2019) examine the preference of firms with high Tobin's Q toward foreign direct investment and foreign outsourcing. Wu et al. (2021) examine the role of endogenous discounting to explain the relationship between Tobin's Q and investment.

2.3 ESG Performance and Corporate Investment

A recent study by Duque-Grisales and Aguilera-Caracuel (2019) find that for certain firms, attaining high ESG performance requires a significant level of investment. The amount of investment can be substantial, which may hamper the financial performance of firms. In line with their study, Rassier and Earnhart (2010) argue that to raise the environmental standard of a firm's production and to adapt to tighter regulation, a firm needs to make substantial investments. On many occasions, this investment is excessive and tends to push the firm to over-compliance.

Furthermore, Sueyoshi and Goto (2009) find that environmental investment, be it long-term (investment) or short-term (expenditure), are not significantly or positively related to firms' financial performance. This finding emphasises that increased costs of environmental investment do not benefit firms financially in either the short or long term. This is especially the case for industries that require large up-front investments, such as electricity generation. Regarding the social pillars, Reimann et al. (2012) find that pressures from local stakeholders will induce firms to make social investments in order to gain social legitimacy. In other words, firms need to spend more to achieve higher social performance. The above studies are substantial to make an important inference: to perform well on ESG, firms need to invest more. The question then is regarding whether this induces overinvestment.

Literature on overinvestment has recently emerged, especially after the global financial crisis (GFC) in 2008. In general, overinvestment is defined as a phenomenon in which firms invest more than they should, given their financial condition and economic situation. Although overinvestment could yield a higher return in the short run, it might have an adverse impact in the long run by consuming future demand ahead of time, potentially damaging the economy. Therefore, it is instructive to investigate the tendency of firms to overinvest and the possible factors behind it.

Richardson (2006) introduces an accounting-based framework to measure the phenomenon of overinvestment. He defines overinvestment as a form of investment that exceeds the normal

or expected level, given the firm's characteristics and economic conditions. Specifically, the residual from the firms' estimated investment function is defined as misinvestment. A positive value of this residual represents overinvestment, while a negative value represents underinvestment. This definition is among the most popular measures because of its straightforward and easy-to-compute characteristics, requiring only balance sheet information. Studies that adopt this framework for overinvestment analysis include Zhang and Su (2015), Guariglia and Yang (2016), Wei et al. (2019), Yu et al. (2020), and Irawan and Okimoto (2020). For example, Irawan and Okimoto (2020) analyze the overinvestment phenomenon among natural resource companies across G20 countries and find that the overinvestment phenomenon is both sector- and time-specific. Further, macroeconomic uncertainties play an essential role in explaining firms' over- and underinvestment behavior. This study contributes to the literature by examining whether ESG scores play a role in inducing firms' overinvestment.

3 Data

This study involves companies that are constituent members of the S&P Global 1200 index, which capture approximately 70% of global market capitalization. A total of 1,045 companies are included in the analysis after excluding several companies that are dual-listed. Furthermore, following the Industrial Classification Benchmark (ICB), companies are grouped into 11 sectors.[1] The data are in annual frequency, covering the period from 2002 to 2019.

3.1 ESG Performance

For ESG performance, this study employs the ESG score provided by Refinitiv. The scores are reported annually, with a total of more than 450 ESG metrics assessed. The earliest data are collected in 2002.[2]

Refinitive provides ESG scores across four hierarchical levels. At the highest level, or Level 1, is the *ESG combined score*, which represents the highest aggregation of all metrics assessed. Level 2 consists of two broad scores: the *ESG Score* and the *ESG Controversies Score*. At Level 3, the ESG Score is further divided into three main pillars: Environmental (E), Social (S), and Governance (G). Further, at Level 4, the Environmental pillar is catego-

[1] The eleven sectors are as follows: (1) basic materials; (2) consumer discretionary; (3) consumer staple; (4) energy; (5) financials; (6) health care; (7) industrials; (8) real estate; (9) technology; (10) telecom; and (11) utilities.

[2] For detailed information about the ESG scores, see Refinitiv Datastream (2020).

rized into resource use, emissions, and innovation; the Social pillar is divided into workforce, human rights, community, and product responsibility; and the Governance pillar comprises management, shareholders, and CSR. Meanwhile, the ESG Controversies Score consists of a single pillar at Level 3, the *ESG Controversy*, which at Level 4 is divided into 10 controversy categories.

Specifically, this study conducts analyzes using data at Level 1 (ESG combined score) and Level 3 (ESG pillars). There are two reasons for focusing on these two levels. The first is to simplify the analysis because it is difficult to find a general pattern if numerous categories are involved. Second, these two levels are consistent and comparable to previous empirical researches. Many studies have analyzed ESG scores from different sources, which may involve different metrics of analysis. Nevertheless, in general, all are aggregated into the three main pillars of the ESG: environment, social, and governance. The descriptive statistics of the ESG scores are presented in Table 1.

[Table 1].

3.2 PRI Signatories

The PRI is a UN-sponsored global movement to promote sustainable and responsible investment practices among investors. It focuses on the active incorporation and promotion of ESG factors in investment activities. The initiative was launched in April 2006 and since then the number of institutional signatories has grown from 100 to more than 5,300 in 2023.

In this study, the number of PRI signatories is used as a proxy for investor ESG awareness and serves as a transition variable in the smooth-transition model, as detailed below. This approach aims to investigate whether and how a significant increase in ESG awareness amplifies the impact of ESG performance on firms within the sample.

3.3 Firm-Level Financial Data

For all firm-level variables, the data are in annual frequency, mainly referring to the end-of-year financial statement for each year. All variables are transformed into natural log forms or divided by total assets. All data are retrieved from Datastream in the local currency where the firm is listed. There are nine variables employed from the firm financial statement: (1) total book assets, (2) market capitalization, (3) book equity, (4) book liabilities, (5)

gross income, (6) total sales, (7) capital expenditure, (8) cash dividend, and (9) cash.[3] The descriptive statistics of the variables are presented in Table 1.

3.4 Macroeconomic Data

The firms analyzed in this study come from multiple countries, making it essential to account for country-specific heterogeneity. To address this, the analysis incorporates macroeconomic variables at both the global and national levels.

At the global level, three variables are employed. The first is the annual world GDP growth ($WGDP$), which represents the global business cycle and is retrieved from the World Bank. The second variable is the annual commodity price growth ($COMM$), which represents the commodity price cycle and is measured by the Goldman Sachs Commodity Index (GSCI). The GSCI is chosen because it is one of the most popular commodity price indices in the financial market. In addition, it is based on the future instead of spot prices. This characteristic is essential as a proxy for the expectation of future prices. The GSCI is available almost in real-time, and the annual average of the daily closing price is used to calculate commodity price growth. The third variable is the global economic policy uncertainty ($GEPU$) index from Davis (2016). This index is a media-based index measuring global economic policy uncertainty based on words related to uncertainty found in key mass media worldwide.[4]

At the country level, three variables are employed. The first two variables are the annual home country GDP growth ($HGDP$) and annual home country inflation rate ($INFL$), which represent the home country's business cycle and inflation, where the company domiciles. These data are retrieved from the World Bank. The third is the Worldwide Governance Index (WGI), which is an average of six categories: (1) voice and accountability; (2) political stability and the absence of violence/terrorism; (3) government effectiveness; (4) regulatory quality; (5) the rule of law; and (6) control of corruption. The WGI ranges from -2.5 to 2.5, where a higher value indicates better governance. For ease of analysis, the WGI is inverted by multiplying by -1, so that a higher value represents higher uncertainty.

[3]Respective Refinitiv Datastream code for each variable is as follows: (1) total book assets - WC02999, (2) market capitalization - WC08001, (3) book equity - WC03995, (4) book liabilities - WC03351, (5) gross income - WC01100, (6) total sales - WC01001, (7) capital expenditure - WC04601, (8) cash dividend - WC04551, and (9) cash - WC02003.

[4]The data are updated monthly by Davis (2016) and published on the respective website of the author at https://www.policyuncertainty.com/global_monthly.html.

4 Methodology

Based on the literature discussed in section 2, this study formulates three analyzes. The first analysis focuses on the relationship between ESG performance, ESG awareness, and firm value. The second analysis investigates firms' overinvestment pattern in the dataset, utilizing the framework developed by Richardson (2006). This approach involves constructing an overinvestment dummy variable that indicates whether each company is overinvesting or underinvesting at a given point in time. The third analysis explores whether ESG performance and ESG awareness can explain firms' overinvestment tendencies. This analysis extends the framework of Irawan and Okimoto (2020), which is developed to assess how macroeconomic uncertainty may induce overinvestment in natural resource companies worldwide.

Each analysis in this study adopts and extends the methodologies from the literature. All three analyzes use firm-level data, especially the first and second analyses. Such settings make analyzes prone to endogeneity and reverse causality issues. To address this concern, following the strategy implemented by Richardson (2006), all independent variables for each analysis are lagged by one period.

4.1 ESG and Firm Value

In this analysis, the relationship between ESG performance and firm value is examined. The dependent variable for this analysis is Tobin's Q, which represents the firm market value of assets divided by the book value of assets, as follows:

$$Tobin's\ Q = \frac{Market\ Equity + Book\ Liabilities}{Book\ Equity + Book\ Liabilities}. \tag{1}$$

The basic framework for the analysis is adapted from many studies analyzing the relationship between firm value and ESG performance, such as Aouadi and Marsat (2018), Fatemi et al. (2018), and Li et al. (2018). The estimation is conducted using panel ordinary least squares (OLS) with firm fixed effects and without time fixed effects, as time variation is controlled by macroeconomic variables. To address potential heteroskedasticity, Huber-White robust standard errors are calculated. All independent variables are lagged for one period to mitigate an endogeneity issue. The equation estimated for this analysis employing the Level 1 ESG score is as follows:

$$\begin{aligned} Q_{i,t} \;=\; & \alpha + \beta COMB_{i,t-1} + \delta_1 SIZE_{i,t-1} + \delta_2 ROA_{i,t-1} + \delta_3 SALES_{i,t-1} + \delta_4 LEV_{i,t-1} \\ & + \delta_5 CAPX_{i,t-1} + \delta_6 DIV_{i,t-1} + \delta_7 HGDP_{i,t-1} + \delta_8 WGDP_{t-1} + u_i + e_{i,t}. \end{aligned} \tag{2}$$

where subscript i denotes firm, and subscript t denotes the year. The term Q is Tobin's Q, as defined in Equation (1). The term $COMB$ refers to the combined ESG score. Meanwhile, for the analysis employing Level 3 ESG scores, this term is replaced by the four ESG pillar terms: environmental (ENV), social (SOC), corporate governance (CGV), and controversies (CTR). For Level 3 analysis, estimations are conducted separately for each pillar to avoid possible multicollinearity problem.

Other variables are control variables that have been commonly employed in previous studies. Term $SIZE$ refers to log-transformed total assets, while the term ROA refers to the return on assets, calculated as gross income divided by total assets. $SALES$ represents total sales divided by the total assets. LEV represents the ratio of total liabilities to total assets. $CAPX$ represents total capital expenditure divided by total assets. DIV represents the total cash dividend payout divided by total assets. $HGDP$ is the annual GDP growth of the home country where firm i is located, $WGDP$ is the annual world GDP growth. u represents firm fixed effects. Finally, the term e represents the residuals.

As discussed, the ESG investments have been increasing over the last 15 years with promoting the ESG awareness of investors. This implies that the ESG scores might have a stronger impact on firm values, since the investors pay more attention to firms' ESG performance and have more incentive to invest in those firms with higher ESG scores. To examine this possibility, we introduce the smooth-transition (ST) model to the coefficient on the ESG score, β, in Equation (2). Specifically, we model a time-varying β using a ST model as follows:

$$\beta_t = (1 - G_t)\beta_1 + G_t\beta_2 \tag{3}$$

where $G_t = G(s_t; c, \gamma)$ is a transition function taking values between 0 and 1 with a transition variable s_t and parameters c and γ. If $G_t = 0$, $\beta_t = \beta_1$, while if $G_t = 1$, $\beta_t = \beta_2$. In this sense, the ST model, defined in Equation (3), can be seen as a two-regime model. In general, β_t will be a weighted average of β_1 and β_2 with a weight determined by the transition function G_t. We will refer to the regime characterized by β_1 as Regime 1 and the regime associated with β_2 as Regime 2.

The transition function and transition variable are selected based on the objective of the analysis. For example, Lin and Teräsvirta (1994) investigate a continuous permanent regime change using the logistic transition function with a time-trend transition variable. Following

a similar idea, we use a logistic transition function given as

$$G(s_t; c, \gamma) = \frac{1}{1 + \exp(-\gamma(s_t - c))}, \quad \gamma > 0, \tag{4}$$

and the number of PRI signatories at time $t-1$, PRI_{t-1}, as transition variable,[5] i.e. $s_t = PRI_{t-1}$.

With this choice of transition function and variable, G_t takes a value close to zero with a smaller s_t when the number of PRI signatories is small. Therefore, we can interpret β_1 as the impact of ESG score on firm values when the investor awareness of ESG investments, measured by the PRI signatories, is small. On the other hand, G_t approaches one with a larger s_t as PRI gets larger, suggesting that β_2 can be interpreted as the impact of ESG score on firm values when the investor awareness of ESG investments is large. More generally, β_t is a weighted average of β_1 and β_2 and if s_t is smaller (larger) than c, β_1 (β_2) has more weight. Thus, we can consider that the location parameter c determines the timing of regime change from β_1 to β_2. The smoothness parameter γ determines the speed of the transition from β_1 to β_2 as the ESG awareness increases. More specifically, when γ takes a large value, the transition is abrupt, whereas the transition is gradual for small values of γ. One of the advantages of the ST model is that we can decide the best transition patterns based on the data by estimating c and γ.

4.2 Overinvestment

The analysis in this stage aims to examine the overinvestment patterns of firms in the sample during the sample period. Simultaneously, this analysis also focuses on how market value influences firms' investment decisions.

The framework from Richardson (2006) is adopted for this purpose. This approach is widely used in the literature for measuring overinvestment, mainly because of its intuitive definition and ease of implementation, requiring only financial statement information. It has been applied in numerous studies, including Zhang and Su (2015), Guariglia and Yang (2016), Wei et al. (2019), Yu et al. (2020), and Irawan and Okimoto (2020). Following Richardson (2006), capital expenditure divided by total assets ($CAPX$) is employed as a proxy for new firm investment, representing the total amount of new capital invested. While alternative measures, such as stock or total investments, could be used, this study focuses on firm's new investments decisions, making the flow of investment a suitable indicator.

[5]Precisely speaking, we normalize PRI so that it has mean of 0 and the standard deviation of 1.

This proxy of investment is used to predict the investment functions of firms in the sample. The equation is estimated as panel OLS with firm fixed effects and the Huber-White robust standard error is calculated. Specifically, the investment function regression of firms is as follows:

$$\begin{aligned} CAPX_{i,t} &= \alpha + \delta_1 Q_{i,t-1} + \delta_2 LEV_{i,t-1} + \delta_3 CASH_{i,t-1} + \delta_4 SIZE_{i,t-1} \\ &\quad + \delta_5 RTRN_{i,t-1} + \delta_6 WGDP_{t-1} + \delta_7 HGDP_{i,t-1} + u_i + e_{i,t} \\ &= \alpha + \delta_1 Q_{i,t-1} + \delta_2 LEV_{i,t-1} + \delta_3 CASH_{i,t-1} + \delta_4 SIZE_{i,t-1} \\ &\quad + \delta_5 RTRN_{i,t-1} + \delta_6 WGDP_{t-1} + \delta_7 HGDP_{i,t-1} + \mu_{i,t}. \end{aligned} \tag{5}$$

where $CASH$ represents total cash divided by total assets, and $RTRN$ is the annual growth in the market capitalization of the firm. Designs of the estimation adopt the framework from Richardson (2006), including the choice of independent variables. All independent variables are lagged by one year to avoid the endogeneity problem, as in Richardson (2006).

The last term, $\mu_{i,t} = u_i + e_{i,t}$, technically the sum of the firm fixed effect and the residual, is the proxy of over- and underinvestment. A positive value of μ represents overinvestment, and a higher value indicates a higher degree of overinvestment. Conversely, a negative value of μ represents underinvestment, and a more negative value indicates a higher degree of underinvestment.

4.3 ESG and Overinvestment

The third analysis focuses on examining whether ESG performance can explain over- and underinvestment behavior observed in the second analysis. To this end, this study employs the framework of Irawan and Okimoto (2020), who examine the impact of macroeconomic uncertainty on resource firm overinvestment behavior. In this framework, the proxy of overinvestment, μ, based on Equation (5), is transformed into a dummy variable, $OVIT$, as follows:

$$OVIT_{i,t} = \begin{cases} 1 & if \quad \mu_{i,t} > 0 \\ 0 & if \quad \mu_{i,t} < 0 \end{cases} \tag{6}$$

In other words, overinvestment is proxied by value 1, while underinvestment is proxied by value 0. Furthermore, the value of $OVIT$ is employed as the dependent variable for the estimation. The estimation is conducted using a panel linear probability model with firm fixed effects and the Huber-White robust standard error is calculated. The equation

estimated for this analysis when employing Level 1 ESG score is as follows:

$$\begin{aligned} OVIT_{i,t} = 1 \quad = \quad & \alpha + \beta_t COMB_{i,t-1} + \delta_1 COMM_{i,t-1} + \delta_2 WGDP_{t-1} + \delta_3 HGDP_{i,t-1} \\ & + \delta_4 GEPU_{i,t-1} + \delta_5 WGI_{t-1} + \delta_6 INFL_{i,t-1} + u_i + e_{i,t}. \end{aligned} \tag{7}$$

For analyzes employing Level 3 ESG scores, estimations are conducted separately for each of the four pillars by replacing the term $COMB_{i,t-1}$ is replaced with ESG pillar terms. Other variables are the macroeconomic variables described in the previous sections, which serve as controls. The ST model (3)-(4) is employed again to model β_t to examine the possible time-varying impact of ESG scores on firm's overinvestment behavior.

5 Empirical Results

This section presents the empirical results of the three analyzes conducted in this study. The first analysis examines the relationship between ESG performance and firm value, as assessed by Tobin's Q. The second analysis discusses the overinvestment patterns of firms in the sample. Finally, the third analysis further examines the results of the second by investigating the connection between ESG performance and the over- and underinvestment of firms in the sample. For each analysis, results are presented based on the ESG scores (combined score and pillars) and sectors. Furthermore, the first and third analyzes investigate the effects of the increasing popularity and awareness of ESG factors globally as proxied by the number of PRI signatories based on the ST model.

5.1 ESG and Firm Value

Many studies exhibit a positive relationship between ESG performance and firm value, such as Hartzmark and Sussman (2019), Li et al. (2018), Wong et al. (2020), Mervelskemper and Streit (2017), Dimson et al. (2015), Aouadi and Marsat (2018), and Fatemi et al. (2018). The aim of this analysis is to replicate these studies for firms in the dataset as a first step, and then to provide additional insights by considering the ESG pillars and awareness. ESG awareness is proxied by the number of PRI signatories. The framework from Aouadi and Marsat (2018) is adopted, as expressed by Equation (2). The dependent variable for this analysis is Tobin's Q, calculated using Equation (1). One significant contribution of this analysis to the literature is that it takes ESG awareness (PRI signatories) into consideration to assess the impacts of ESG scores on firm values.

Tables 2-3 present the results of the estimation using combined ESG score ($COMB$) with and without the smooth-transition framework (3)-(4) using the PRI signatories as a transition variable. Each table presents the results for the full sample and 11 sectors. The first row of Table 2 shows that $COMB$ has significant positive impacts for the full sample, as well as the basic materials, consumer discretionary, consumer staple, financials, health care, industrials, technology, and utilities sectors. This is a straightforward result that confirms the findings of previous studies, which outline the positive connection between ESG performance and firm value.

Table 3 reports the estimation results based on the ST model that are more compelling. Note that to increase the comparablity across sectors, the results for each sector is based on the estimated transition function for the full-sample. In other words, we fixed γ and c at the estimates for the full-sample,

β_1, which is the coefficient on $COMB$ in Regime 1 characterized by low ESG awareness, is significantly positive only for the utilities sector, but significantly negative for the full sample, as well as for the consumer discretionary, industrials, and real estate sectors. This is a great contrast to the results of Table 2, suggesting that when ESG awareness is low, the firms' ESG performance does not positively affect firm value and may even be negatively perceived in some sectors. In contrast, β_2, which is the coefficient on $COMB$ in Regime 2 characterized by high ESG awareness, is significant and positive for most sectors, specifically for the full sample, as well as for the basic materials, consumer discretionary, consumer staple, financials, health care, industrials, technology, and utilities sectors. These results demonstrate that as ESG awareness increases, the positive impact of ESG performance on firm value becomes more pronounced across a broad range of industries.

[Table 2]

[Table 3]

Of the other variables that serve as controls, some of their coefficients are found to be statistically significant (Table 2–3). In general, the coefficient on $SIZE$ is found to be significant and negative for many sectors. These results indicate that large firms generally have a lower Q. The coefficient on ROA is significant and positive for most sectors, while the coefficients on $SALES$, LEV, and $CAPX$ are generally not significant. Meanwhile, the coefficient on DIV is significant and positive in about half of the cases, meaning that

firms with bigger dividends have higher valuations. Finally, $WGDP$ generally shows a countercyclical impact on firm values, while $HGDP$ indicate a procyclical impact.

[Table 4]

In addition, Table 4 summarises of the estimation results for each pillar. The design for these estimations follows Equation (2) and Table 3; however, the results for control variables are suppressed. The results are mostly consistent with those from combined score estimation. In particular, β_1, that is the coefficient of low ESG awareness, of each pillar is not significantly positive for all cases, except for consumer staples for the social score. In contrast, β_2 is significant and positive regardless of the pillars for most sectors except for the energy, real estate, and telecom. The results further demonstrate that the increase in ESG awareness makes the ESG pillars' performance more crucial for firms' valuation.

To visually illustrate the increasing impact of ESG performance on firm value as ESG awareness evolves, Figure 1 plots the dynamics of the total effects of ESG scores on firm value for the full sample, which are expressed by Equation (3). As can be seen, the influence of ESG scores remained very low until 2010, but started to increase sharply with the ESG awareness between 2010 and 2015. Consequently, the total effects of each ESG score in 2020 range from 0.0040 for ENV to 0.0060 for CTR. Given that each ESG score takes a value between 0 and 100, this implies that ESG performance could raise Tobin's Q by up to 0.40 to 0.60 in 2020, demonstrating the sizeable impact of ESG scores on firm value.

[Figure 1]

Figure 2 illustrates the dynamics of β_t across all sectors, distinguishing between those with $\beta_{2020} < 0.004$ and those with $\beta_{2020} \geq 0.004$. Specifically, high-impact sectors plotted in the left panel include consumer discretionary, consumer staples, financials, health care, industrials, and technology. In contrast, basic materials, energy, real estate, telecommunications, and utilities are classified as low-impact sectors and shown in the right panel. The high-impact sectors show a sharp increase in the effects of ESG performance on firm value between 2010 and 2015, with the exception of financial sector, which maintains a relatively high impact even prior to 2010. Among the high-impact sectors, health care and technology sectors exhibit the greatest increases, with impacts ranging from 0.012 to 0.013 in 2020. In contrast, the dynamics of β_t in low-impact sectors differ markedly. Although these sectors

also show increasing impacts, the magnitude is significantly smaller compared to high-impact sectors.

[Figure 2]

There is a strong pattern that can be inferred from this analysis. ESG performance increasingly positively affects firm value as investor ESG awareness grows. These findings align with those reported in numerous studies, including Hartzmark and Sussman (2019), Li et al. (2018), Wong et al. (2020), Mervelskemper and Streit (2017), Dimson et al. (2015), Aouadi and Marsat (2018), and Fatemi et al. (2018). Importantly, the analysis provides novel insights by showing that the positive impact of ESG performance on firm valuation is significantly increased with rising ESG awareness. These results are consistent across the combined ESG score and each pillar. Our analysis also highlights notable differences in the ESG impact on firm value across sectors. High-impact sectors include consumer discretionary, consumer staples, financials, health care, industrials, and technology. However, basic materials, energy, real estate, telecommunications, and utilities sectors deviate from this general pattern. For these sectors, the influence of ESG scores and awareness is generally not significant. Even when significant, the economic impact is limited. For instance, in the energy sector, achieving high ESG performance may necessitate substantial additional investments, leading to lower profitability and firm valuation. This finding coincides with the phenomenon observed among Latin American companies, as discussed by Duque-Grisales and Aguilera-Caracuel (2019) .

5.2 Overinvestment Pattern

This analysis examines the overinvestment patterns of companies in the sample. The basic framework employed for this analysis is adopted from Richardson (2006) and based on residuals from firm investment functions (5). Technically, the investment functions for all firms are estimated together as a one-panel regression using OLS with firm fixed effects. The dependent variable for this analysis is $CAPX$, which is calculated as capital expenditure divided by total assets. The time variation is controlled by adding $WGDP$ and $HGDP$.

Table 5 presents estimation results of investment function specified in Equation (5). For the full sample, coefficients on most variables are statistically significant and exhibit the expected signs, suggesting that the model is reasonably estimated. While the significance of individual variables varies across sectors, the signs of the coefficients generally align with

expectations when they are significant. Specifically, the coefficient on Q is positive and significant in many sectors. The results indicate that firms with higher valuations have greater investment opportunities and, consequently, higher investment rates. The coefficient on LEV is found significant in the full sample, consumer discretionary, energy, health care, technology, and utilities sectors, all with negative signs. This negative relationship implies that firms with high leverage tend to have lower investment rates, which is considerably logical, as high leverage makes it difficult to increase debt further, restricting the primary sources of investment. The coefficients of $CASH$ and $RTRN$ are generally insignificant across most sectors. In contrast, the coefficient on $SIZE$ is typically significant with a negative sign, suggesting that bigger firms tend to invest less compared to smaller firms.

Misinvestment is defined based on the error term μ, of the investment function (5), or, more precisely, if $\mu_{i,t}$ is positive, the firm i in year t is classified as overinvesting and if $\mu_{i,t}$ is negative, the firm i in year t is considered as underinvesting. To see the pattern of misinvestment, we summarise μ by sector and country.

Figure 3 presents μ grouped by sector. The figure shows the variety of misinvestment behavior in each sector during the sample period. As can be seen from the positive first quartiles of these two sectors, firms in the energy and utilities sectors tend to overinvest during this period. Meanwhile, the financials and health care firms are mostly classified as underinvesting.

[Figure 3]

Figure 4 presents μ grouped by country of domicile. As can be observed, some countries tend to overinvest during the period, while others tend to underinvest. Countries that are observed as overinvesting are Austria, Chile, Colombia, Japan, South Korea, Macau, Mexico, Papua New Guinea, and Portugal. Conversely, Belgium, Bermuda, Finland, Ireland, Isle of Man, Luxembourg, Netherlands, New Zealand, and Switzerland are seen to be largely underinvesting during the period.

[Figure 4]

As the framework for the analysis uses residuals, and estimation is conducted in a panel setting, these results represent a comparison of the investment rates between sectors and countries in the observation. The variation between sectors and countries could be caused by

several factors, including (1) the firm's fundamental characteristics, (2) economic conditions, and (3) macroeconomic uncertainties. Therefore, the third analysis, presented in the next section, examines the role of several variables from these factors in the overinvesting behavior of the firm.

5.3 ESG and Overinvestment

The analysis in this section aims to examine whether higher ESG scores induce firms' overinvestment behavior and, if so, which ESG pillar(s) can explain their overinvestment more. In general, higher ESG scores can have two different impacts on overinvestment: on the one hand, they can reduce overinvestment by giving firms greater investment opportunities; on the other hand, firms may need to overinvest to obtain and maintain higher ESG scores, thereby requiring extra effort to enhance ESG engagements. Therefore, it would be instructive to empirically find answers to the above questions.

To this end, the misinvestment residual (μ) from the previous analysis is transformed into a dummy variable ($OVIT$) based on Equation (6) and then used as a dependent variable for the analysis as expressed by Equation (7). The basic framework for this analysis is followed from Irawan and Okimoto (2020), who study how macroeconomic uncertainties may induce overinvestment among natural resource firms worldwide. The approach is modified and extended by adding ESG variables, including both the combined score ($COMB$) and the pillars (ENV, SOC, CGV, and CTR). The samples are estimated together as one panel using linear probability model with firm fixed effects. All regressors are lagged by one year to mitigate the endogeneity issue; Additionally, the increase of ESG awareness is taken into account by applying the smooth-transition model with the number of PRI signatories as a transition variable.

Table 6 shows the estimation results with $COMB$. The variable of interest in this analysis, $COMB$, is largely insignificant across all panels, except in Regime 1 for the full sample, energy, and utilities sectors. This means that $COMB$ tends to induce overinvestment behavior only in these sectors when investor ESG awareness was low. More importantly, $COMB$ is not significant across all sectors in Regime 2, implying that ESG performance has little association with overinvestment in most sectors, even after ESG awareness has increased.

[Table 6]

Other variables in the model, which are mostly macroeconomic variables at both the global and country levels, have mixed results (Table 6). The coefficient on $COMM$, the annual commodity price growth, is significant with positive signs for full sample, energy, industrials, technology, and utilities sectors, while the coefficient on $INFL$ is positively significant for the full sample, energy, industrials, reals estates, and utilities sectors. These results indicate the procyclicality of overinvesting behaviors toward the global and domestic inflation. In contrast, $WGDP$ and $HGDP$ have significantly negative impacts on the overinvestment in some sectors, including consumer staple, energy, financials, health care, and utilities sectors. The coefficient on $GEPU$, which represents global economic uncertainty, is significantly negative for the full sample, consumer stable, energy, industrials, and real estate sectors; thus, it can be inferred that global economic uncertainty tends to reduce the overinvestment in these sectors. The country-level governance uncertainty proxy, WGI, has limited impact on the overinvestment with insignificant coefficient for most of sectors. Overall, our results indicate that inflation tend to induce the overinvestment behavior of the firms in some sectors, while business cycle and economic policy uncertainty negatively affects overinvestment for several sectors.

[Table 7]

Additionally, Table 7 presents the estimation results for each ESG pillar. The estimation follows Equation (6) and Table 6, but the results for control variables are omitted. The findings largely align with those from the combined score estimation. Specifically, ESG pillar scores do not significantly drive overinvestment in most sectors under either regime, suggesting that ESG performance is not a major factor in firms' overinvestment, regardless of investor ESG awareness. A minor exception is the social pillar, which appears to be associated with overinvestment in a limited number of sectors, such as consumer discretionary and telecommunications. However, beyond these cases, no clear link emerges between firms' ESG performance and overinvestment.

The analysis in this section reveals several patterns regarding the relationship of ESG performance with the overinvestment behavior of firms in the sample. First, there is little evidence to suggest that higher ESG performance leads to firms' overinvestment behavior in most sectors. While some studies, such as Duque-Grisales and Aguilera-Caracuel (2019), have argued that firms may need to increase investment to attain high ESG scores, our findings indicate no clear relationship between ESG scores and overinvestment. Second,

this pattern holds across both regimes, suggesting that even as ESG awareness increases, ESG performance does not become a driver of overinvestment. One possible explanation for this is that higher ESG scores expand firms' investment opportunities, thereby reducing overinvestment pressure, even if achieving higher ESG scores requires additional investment. Another plausible interpretation is that as firms become more familiar with ESG initiatives, they may integrate ESG considerations more efficiently into their operations and capital allocation processes, leading to better managed investment decisions.

6 Conclusion

This study examines the relationship between firms' ESG performance, investor ESG awareness, firm value, and firms' overinvestment behavior. The analysis is based on constituent members of the S&P 1200 Index, which comprises companies with the largest capitalization across major global markets, capturing about 70% of the total global market capitalization. The dataset covers the 2002–2019 period in annual frequency.

The first analysis reveals a positive relationship between ESG performance, ESG awareness and firm value, as measured by Tobin's Q. More specifically, ESG performance increasingly positively affects firm value as investor ESG awareness grows. These results are consistent with numerous prior studies documenting a similar positive relationship. However, this study offers additional insight by incorporating the number of PRI signatories as a proxy for investor ESG awareness. Analysis at the pillar level yields a similar pattern, confirming that that the high ESG performance is more strongly associated with higher firm value, as ESG awareness increases. Nonetheless, the results also highlight sector-specific differences in the strength and significance of these relationships.

The second analysis shows that internal firm factors play a significant role in determining firms' investment decisions. One important finding from this analysis confirms that firms with higher Q tend to invest more, as shown by the significant estimation results with positive signs. Furthermore, some sectors are identified as overinvesting in the sample period. They are energy and utilities. Other sectors identified as underinvesting during the sample period are the financials and health care. In addition, based on the country of domicile, the estimation also reveals that firms from Austria, Chile, Colombia, Japan, South Korea, Macau, Mexico, Papua New Guinea, and Portugal have overinvested. Meanwhile, Belgium, Bermuda, Finland, Ireland, Isle of Man, Luxembourg, Netherlands, New Zealand,

and Switzerland are identified as underinvesting.

The third analysis finds little evidence that the ESG performance leads to firms' overinvestment behavior for most sectors. Although some studies, such as Duque-Grisales and Aguilera-Caracuel (2019), have argued that firms may need to increase investment to achieve high ESG performance, our results indicate that there is no clear relationship between ESG scores and overinvestment. Moreover, the results suggest that as ESG awareness increases, firms with higher ESG performance tend to overinvest less in certain sectors. As the previous two analyses suggested, higher ESG scores may reduce overinvestment by expanding firms' investment opportunities. Our results provide empirical support for this conjecture in several sectors.

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7 Figures

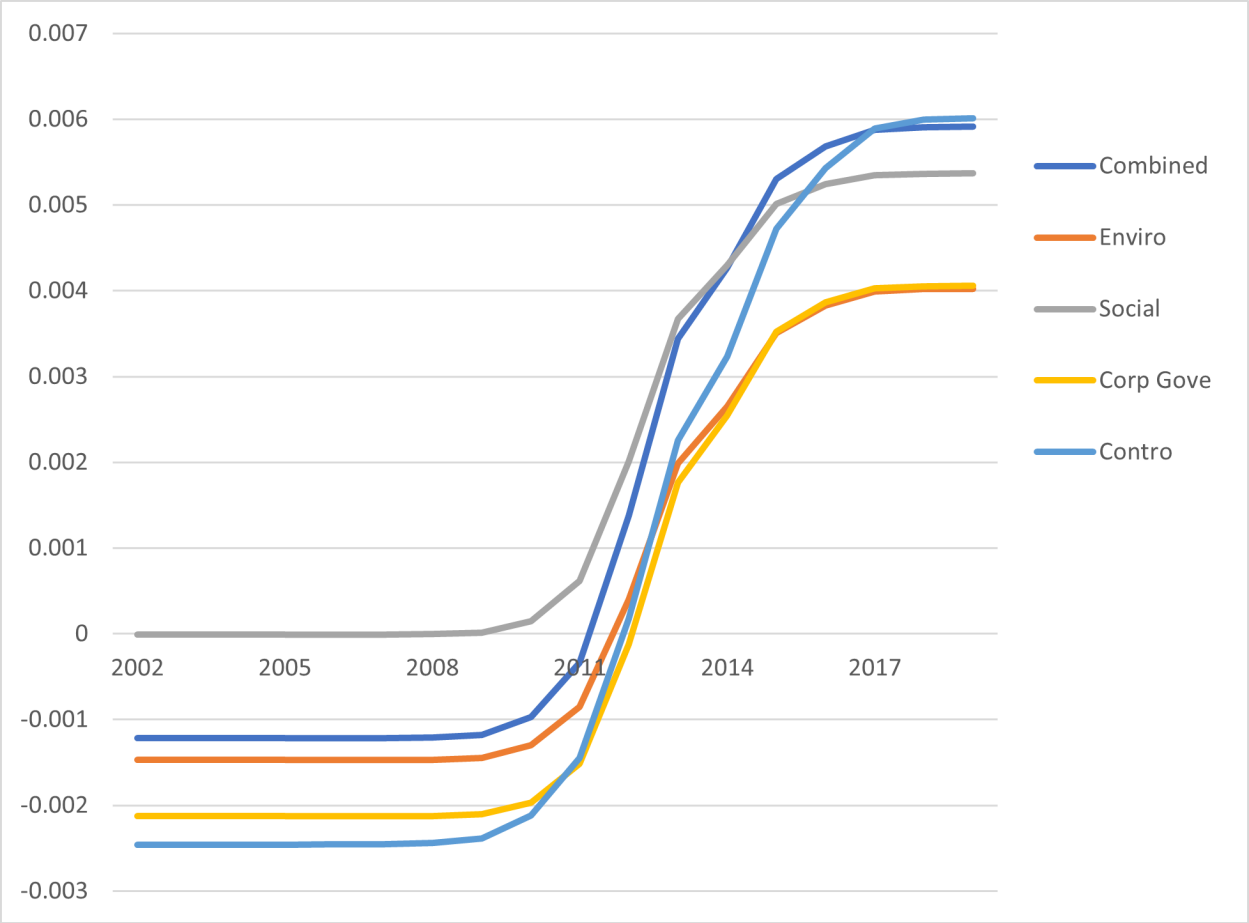


Figure 1: Dynamics of ESG impacts on the firm values

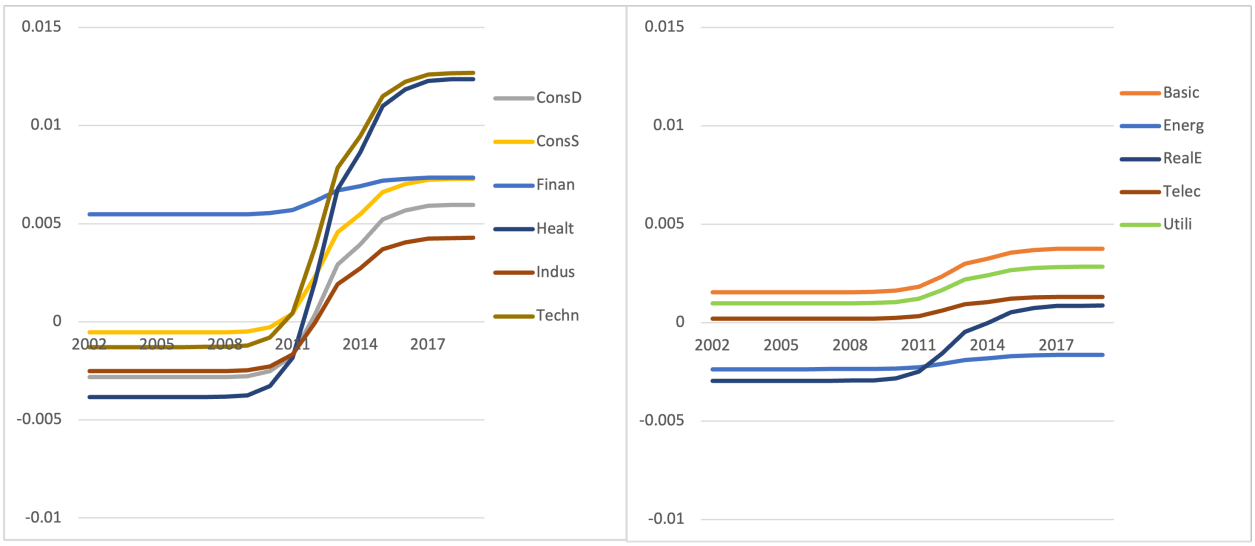


Figure 2: Dynamics of ESG impacts on the firm values by sectors

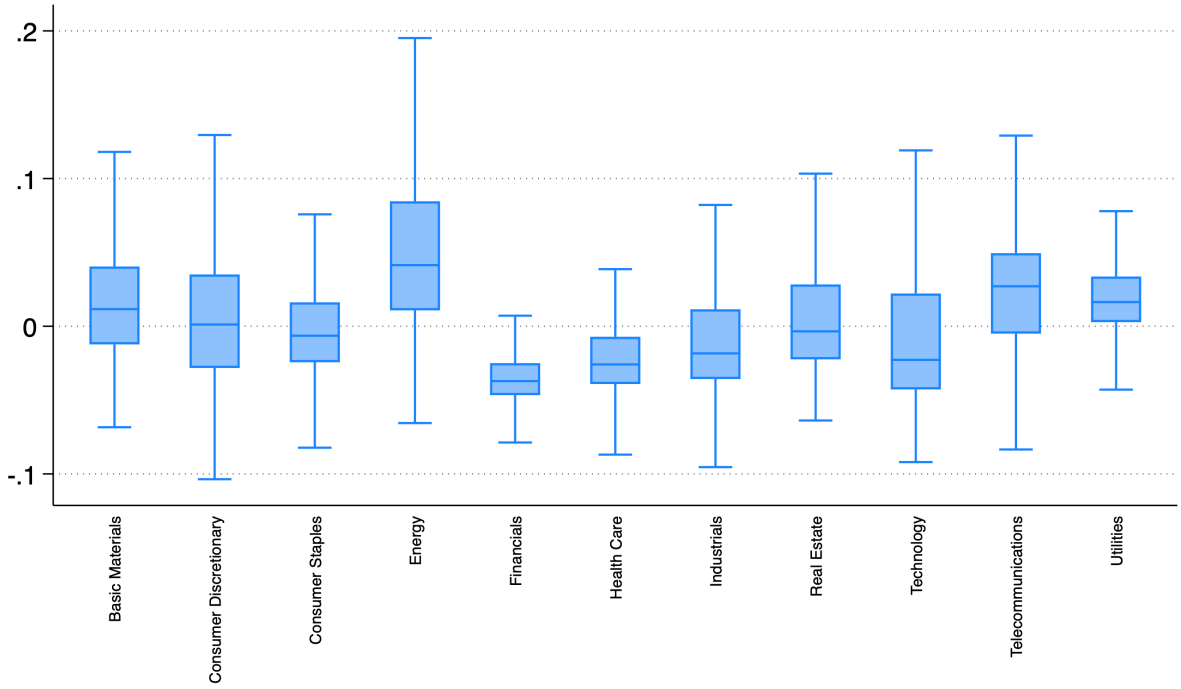


Figure 3: Misinvestment by Sector

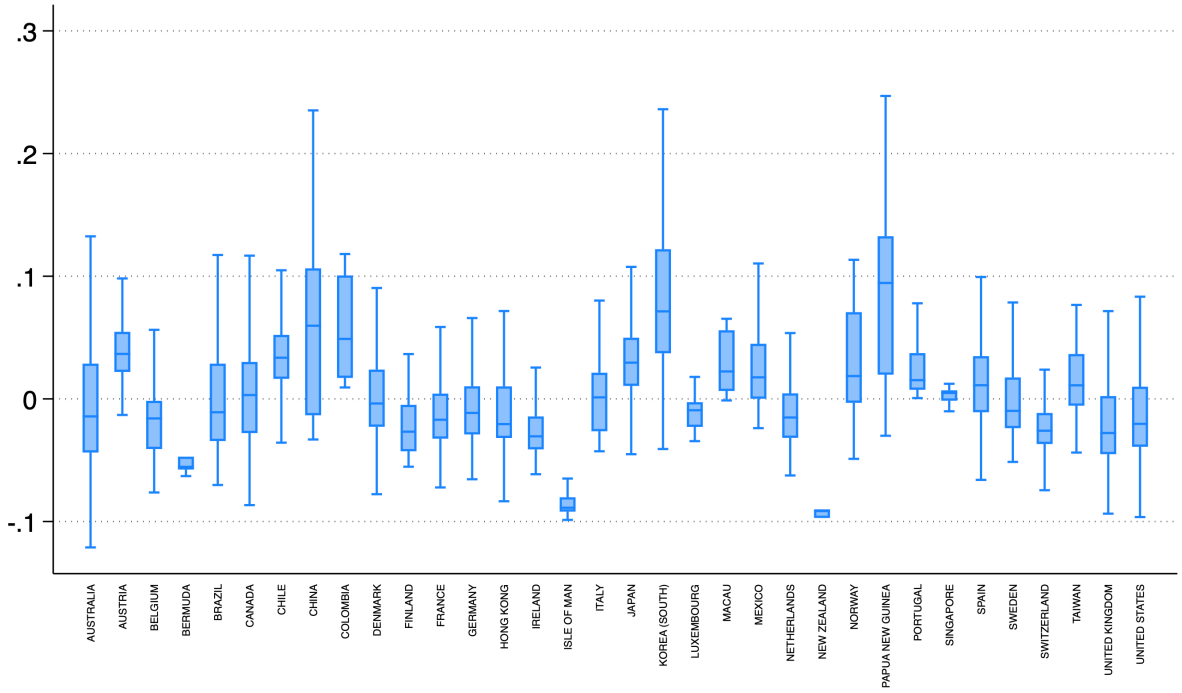


Figure 4: Misinvestment by Country

8 Tables

Table 1: Descriptive Statistics

Variable	Description	Obs	Mean	Std. Dev.	Min	Max
$COMB$	ESG Combined Score	13,778	50.640	16.507	7.310	95.370
ENV	Environmental Pillar Score	13,773	62.313	21.188	4.770	99.420
CGV	Corporate Govt Pillar Score	13,778	57.450	20.757	4.260	99.050
SOC	Social Pillar Score	13,773	62.055	20.149	3.760	99.160
CTR	Controversies Pillar Score	13,773	42.266	24.223	0.110	83.330
Q	Tobin's Q	13,778	1.937	1.152	0.766	8.420
$SIZE$	Log of Total Assets	13,778	17.257	2.254	9.743	26.534
ROA	Gross Income / Total Assets	13,778	0.271	0.196	-1.318	1.570
$SALES$	Sales / Total Assets	13,778	0.829	0.618	0.000	10.364
LEV	Liabilities / Total Assets	13,778	0.268	0.169	0.000	1.940
$CAPX$	Capex / Total Assets	13,778	0.049	0.040	0.000	0.494
DIV	Dividend / Total Assets	13,778	0.025	0.031	0.000	0.641
$CASH$	Cash / Total Assets	15,751	0.082	0.091	0.000	0.984
$RTRN$	Annual Market Cap Growth	15,751	0.075	0.371	-4.028	3.806
$COMM$	Annual Growth of GSCI Index	13,586	-0.005	0.030	-0.073	0.034
$WGDP$	Annual World GDP Growth	13,778	2.844	1.394	-1.679	4.403
$HGDP$	Annual Home Country GDP Growth	13,778	1.843	2.182	-21.594	25.264
$GEPU$	Log of Glob Econ Pol Uncertainty	13,586	4.761	0.326	4.142	5.222
WGI	Worldwide Governance Index	13,583	-1.323	0.306	-1.970	0.706
$INFL$	Home Country Annual Inflation	13,583	1.663	1.357	-4.478	14.715

Note: Tobin's Q is calculated as (Market Equity + Book Liabilities)/(Book Equity + Book Liabilities).

Table 2: ESG and Firms Value - Combined ESG Scores - Without Smooth Transition

Dependent Variable = $Q_{i,t}$

Variable	Full Sample	Basic Materials	Cons Discret	Cons Staple	Energy	Financials	Health Care	Industrials	Real Estate	Technology	Telecom	Utilities
$COMB_{-1}$	0.0038***	0.0032**	0.0026**	0.0045***	-0.0020*	0.0071***	0.0087***	0.0023***	0.0005	0.0077***	0.0007	0.0022***
	(7.23)	(2.17)	(2.05)	(3.07)	(-1.82)	(2.68)	(3.17)	(2.63)	(0.40)	(3.48)	(0.51)	(3.54)
$SIZE_{-1}$	-0.1554***	-0.4284***	-0.0897	0.0224	-0.3414***	-0.0077	-0.0099	0.1244**	0.0440	-0.4242***	-0.4230***	-0.1003*
	(-4.57)	(-6.21)	(-0.99)	(0.35)	(-5.42)	(-0.12)	(-0.07)	(2.23)	(0.66)	(-3.76)	(-3.36)	(-1.95)
ROA_{-1}	1.3745***	1.3922***	1.4851***	0.9402***	0.1945	1.2925	3.2484***	0.3573	2.7521*	1.9828***	1.4369**	1.0010***
	(7.24)	(3.08)	(3.51)	(3.20)	(0.67)	(1.28)	(5.36)	(1.10)	(1.97)	(4.34)	(2.08)	(2.67)
$SALES_{-1}$	-0.0150	-0.2787**	0.0418	-0.0628	0.0583	-1.2525	-0.0709	0.2841*	0.2301	-0.0736	-0.2496	-0.1948*
	(-0.32)	(-2.08)	(0.51)	(-0.83)	(0.76)	(-1.57)	(-0.37)	(1.93)	(1.64)	(-0.27)	(-0.49)	(-1.97)
LEV_{-1}	0.3140**	0.1153	0.3841	0.2701	-0.5394	0.5199	-0.0773	0.5640**	0.2377	1.0707***	0.3371	0.1136
	(2.08)	(0.42)	(1.04)	(0.70)	(-1.58)	(0.88)	(-0.17)	(2.09)	(0.51)	(2.63)	(0.62)	(0.48)
$CAPX_{-1}$	0.0139	-0.2164	-0.3175	0.6035	0.5001	0.0228	0.9604	-1.2077**	0.2921	1.7649	0.4192	0.1732
	(0.04)	(-0.24)	(-0.40)	(0.30)	(0.77)	(0.01)	(0.23)	(-2.08)	(0.71)	(1.21)	(0.20)	(0.44)
DIV_{-1}	3.3016***	2.9952**	3.9165***	9.3114***	3.6973**	6.3841	2.1014	4.9987***	3.4633	-0.0815	0.7325	0.5265*
	(4.97)	(2.18)	(2.70)	(7.12)	(2.55)	(1.54)	(0.52)	(2.99)	(1.40)	(-0.06)	(0.85)	(1.85)
$WGDP_{-1}$	-0.0365***	-0.0500***	-0.0371	-0.0389*	-0.0032	0.0224	0.0010	-0.0310***	-0.0570***	-0.1201**	-0.0293	-0.0083
	(-4.67)	(-3.14)	(-1.30)	(-1.83)	(-0.22)	(0.87)	(0.04)	(-3.82)	(-2.89)	(-2.32)	(-1.35)	(-1.00)
$HGDP_{-1}$	0.0396***	0.0134	0.0303	0.0650***	0.0200	0.0026	0.0428	0.0304***	0.0678***	0.1023**	0.0365**	0.0284***
	(5.60)	(1.30)	(1.16)	(3.08)	(1.35)	(0.12)	(1.62)	(4.84)	(3.93)	(2.09)	(2.35)	(3.43)
constant	3.9331***	8.9029***	2.8011*	0.8424	7.4118***	1.3704	1.0534	-0.9344	0.2340	8.6633***	8.9030***	2.7313***
	(6.37)	(7.21)	(1.69)	(0.72)	(6.73)	(1.10)	(0.42)	(-0.89)	(0.18)	(4.26)	(3.71)	(3.02)
N	13778	1071	2632	1196	819	432	1240	2839	699	1244	637	969
R^2	0.091	0.234	0.078	0.216	0.251	0.148	0.141	0.097	0.168	0.171	0.187	0.175

Note: The significance level is shown by ***, **, *, to denote respectively 1%, 5%, and 10% significance level.

Table 3: ESG and Firms Value - Combined ESG Scores - With Smooth Transition

Dependent Variable = $Q_{i,t}$

Variable	Full Sample	Basic Materials	Cons Discret	Cons Staple	Energy	Financials	Health Care	Industrials	Real Estate	Technology	Telecom	Utilities
β_1	-0.0012**	0.0015	-0.0028**	-0.0005	-0.0024	0.0054	-0.0039	-0.0025***	-0.0029**	-0.0013	0.0002	0.0010*
	(-2.45)	(1.02)	(-2.30)	(-0.36)	(-1.62)	(1.37)	(-1.52)	(-2.96)	(-2.24)	(-0.61)	(0.13)	(1.68)
β_2	0.0059***	0.0037**	0.0059***	0.0073***	-0.0016	0.0071***	0.0122***	0.0043***	0.0009	0.0127***	0.0013	0.0029***
	(10.48)	(2.40)	(3.99)	(4.42)	(-1.26)	(2.71)	(4.47)	(4.72)	(0.76)	(5.10)	(0.79)	(4.15)
$SIZE_{-1}$	-0.3287***	-0.4669***	-0.3616***	-0.1951**	-0.3593***	-0.0334	-0.3489**	-0.0867	-0.0653	-0.7205***	-0.4427***	-0.1704***
	(-9.03)	(-7.69)	(-3.60)	(-2.58)	(-5.09)	(-0.43)	(-2.47)	(-1.53)	(-1.03)	(-5.78)	(-3.50)	(-2.90)
ROA_{-1}	1.2818***	1.4255***	1.2744***	0.7331***	0.2081	1.2796	3.2894***	0.2580	2.8481**	1.5070***	1.4368**	1.1785***
	(7.14)	(3.21)	(3.06)	(2.69)	(0.71)	(1.25)	(5.53)	(0.93)	(2.10)	(3.55)	(2.09)	(3.21)
$SALES_{-1}$	0.0234	-0.2005	0.0119	-0.0158	0.0684	-1.2259	-0.0049	0.2790**	0.1840	-0.1105	-0.1989	-0.2480**
	(0.50)	(-1.41)	(0.16)	(-0.17)	(0.91)	(-1.60)	(-0.02)	(2.07)	(1.64)	(-0.41)	(-0.38)	(-2.62)
LEV_{-1}	0.2316	0.1672	0.3867	0.1493	-0.5988	0.4942	-0.1977	0.5783**	0.3900	0.7154*	0.2641	0.1074
	(1.56)	(0.58)	(1.14)	(0.40)	(-1.54)	(0.87)	(-0.47)	(2.28)	(0.86)	(1.97)	(0.51)	(0.49)
$CAPX_{-1}$	0.4752	-0.0912	-0.3513	1.3055	0.5575	0.1348	2.0237	-0.5874	0.2430	3.2668**	0.4053	0.2551
	(1.32)	(-0.10)	(-0.47)	(0.64)	(0.84)	(0.07)	(0.48)	(-0.92)	(0.59)	(2.51)	(0.19)	(0.64)
DIV_{-1}	2.2363***	2.7222**	2.5082*	7.1925***	3.6057**	6.0230	-1.8063	3.6188**	2.4858	-0.8461	0.6098	0.4117
	(3.72)	(2.14)	(1.96)	(6.03)	(2.54)	(1.32)	(-0.46)	(2.58)	(1.07)	(-0.64)	(0.68)	(1.51)
$WGDP_{-1}$	-0.0254***	-0.0494***	-0.0208	-0.0211	-0.0034	0.0168	0.0045	-0.0174**	-0.0445***	-0.0726*	-0.0286	-0.0022
	(-3.56)	(-3.11)	(-0.79)	(-1.41)	(-0.23)	(0.70)	(0.23)	(-2.15)	(-2.77)	(-1.92)	(-1.30)	(-0.30)
$HGDP_{-1}$	0.0246***	0.0103	0.0137	0.0419***	0.0188	0.0061	0.0247	0.0152**	0.0499***	0.0505	0.0358**	0.0198***
	(3.91)	(1.08)	(0.58)	(2.87)	(1.27)	(0.26)	(1.37)	(2.48)	(3.65)	(1.50)	(2.29)	(2.81)
constant	7.0341***	9.5305***	7.7047***	4.7630***	7.7300***	1.8673	7.0949***	2.8176***	2.1200*	14.0335***	9.2625***	3.9826***
	(10.87)	(8.90)	(4.25)	(3.57)	(6.16)	(1.23)	(2.76)	(2.72)	(1.74)	(6.27)	(3.87)	(3.95)
N	13778	1071	2632	1196	819	432	1240	2839	699	1244	637	969
R^2	0.138	0.242	0.123	0.289	0.251	0.150	0.228	0.168	0.219	0.243	0.188	0.214

Note: The significance level is shown by ***, **, *, to denote respectively 1%, 5%, and 10% significance level.

Table 4: ESG and Firms Value - ESG Scores Pillars - With Smooth Transition

Dependent Variable = $Q_{i,t}$

Variable	Full Sample	Basic Materials	Cons Discret	Cons Staple	Energy	Financials	Health Care	Industrials	Real Estate	Technology	Telecom	Utilities
Environmental												
β_1	-0.0015**	0.0016	-0.0019	-0.0016	-0.0063***	0.0037	-0.0032	0.0004	-0.0024	-0.0070*	-0.0058*	0.0001
	(-2.14)	(0.87)	(-0.93)	(-1.06)	(-3.04)	(1.06)	(-1.08)	(0.38)	(-1.67)	(-1.87)	(-1.88)	(0.09)
β_2	0.0040***	0.0032*	0.0045**	0.0040**	-0.0056**	0.0069**	0.0093***	0.0053***	0.0001	0.0042	-0.0043	0.0017*
	(5.54)	(1.69)	(2.13)	(2.24)	(-2.46)	(2.13)	(3.07)	(4.79)	(0.08)	(1.15)	(-1.34)	(1.89)
N	13773	1071	2632	1196	819	432	1240	2839	699	1239	637	969
R^2	0.131	0.237	0.119	0.265	0.270	0.156	0.218	0.162	0.195	0.235	0.202	0.195
Social												
β_1	-0.0000	0.0017	0.0003	0.0025*	-0.0018	0.0009	0.0026	-0.0030***	-0.0040***	-0.0017	-0.0034*	0.0007
	(-0.02)	(0.93)	(0.19)	(1.70)	(-1.10)	(0.24)	(0.84)	(-3.28)	(-3.22)	(-0.48)	(-1.78)	(0.89)
β_2	0.0053***	0.0032	0.0068***	0.0076***	-0.0015	0.0044	0.0126***	0.0025***	-0.0002	0.0089**	-0.0022	0.0020**
	(7.49)	(1.65)	(4.03)	(4.12)	(-0.84)	(1.25)	(4.15)	(2.63)	(-0.16)	(2.36)	(-1.15)	(2.43)
N	13773	1071	2632	1196	819	432	1240	2839	699	1239	637	969
R^2	0.132	0.236	0.126	0.277	0.249	0.140	0.211	0.164	0.232	0.229	0.193	0.184
Corporate Governance												
β_1	-0.0021***	-0.0020	-0.0039***	0.0002	-0.0031**	0.0006	-0.0070**	-0.0016*	-0.0008	-0.0022	-0.0026	0.0004
	(-3.79)	(-1.19)	(-2.63)	(0.11)	(-2.13)	(0.20)	(-2.52)	(-1.92)	(-0.63)	(-1.02)	(-1.27)	(0.67)
β_2	0.0041***	0.0004	0.0041***	0.0053***	-0.0017	0.0041	0.0060**	0.0043***	0.0034**	0.0105***	-0.0014	0.0024***
	(6.88)	(0.22)	(2.73)	(3.75)	(-1.12)	(1.14)	(2.32)	(4.74)	(2.63)	(3.57)	(-0.67)	(3.39)
N	13778	1071	2632	1196	819	432	1240	2839	699	1244	637	969
R^2	0.134	0.238	0.125	0.258	0.254	0.141	0.213	0.167	0.242	0.240	0.192	0.223
Controversies												
β_1	-0.0025***	-0.0005	-0.0033***	-0.0037***	-0.0006	0.0021	-0.0058***	-0.0025***	-0.0024**	-0.0024	0.0013	-0.0001
	(-7.14)	(-0.53)	(-3.39)	(-4.25)	(-0.51)	(0.98)	(-3.83)	(-4.87)	(-2.19)	(-1.48)	(1.02)	(-0.25)
β_2	0.0060***	0.0030**	0.0055***	0.0068***	0.0005	0.0036**	0.0129***	0.0050***	0.0031**	0.0132***	0.0023	0.0025***
	(13.00)	(2.46)	(4.57)	(5.17)	(0.38)	(2.52)	(5.78)	(6.25)	(2.66)	(6.40)	(1.52)	(4.77)
N	13773	1071	2632	1196	819	432	1240	2839	699	1239	637	969
R^2	0.133	0.241	0.110	0.300	0.248	0.131	0.218	0.160	0.235	0.227	0.192	0.209

Note: The significance level is shown by ***, **, *, to denote respectively 1%, 5%, and 10% significance level.

Table 5: Investment Function

Dependent Variable = $CAPX_{i,t}$

Variable	Full Sample	Basic Materials	Cons Discret	Cons Staple	Energy	Financials	Health Care	Industrials	Real Estate	Technology	Telecom	Utilities
Q_{-1}	0.0009***	0.0157***	0.0006***	0.0048**	0.0343***	0.0014	0.0031***	0.0007	0.0365***	0.0023**	0.0006	0.0083
	(3.47)	(3.76)	(8.38)	(2.54)	(3.76)	(0.83)	(5.16)	(0.94)	(4.48)	(2.51)	(0.43)	(1.01)
LEV_{-1}	-0.0182***	0.0218	-0.0380***	-0.0164**	-0.1418***	-0.0028	-0.0119	0.0045	-0.0013	-0.0369***	0.0180	-0.0566**
	(-3.03)	(0.75)	(-4.58)	(-2.34)	(-4.90)	(-0.29)	(-1.64)	(0.41)	(-0.07)	(-4.13)	(1.12)	(-2.24)
$CASH_{-1}$	-0.0133***	-0.0232	0.0056	-0.0183	-0.1425***	-0.0123	-0.0246***	-0.0156	0.0063	0.0053	0.0105	-0.0618
	(-2.72)	(-0.63)	(0.52)	(-1.02)	(-4.11)	(-1.66)	(-3.10)	(-1.30)	(0.10)	(0.47)	(0.66)	(-1.23)
$SIZE_{-1}$	-0.0081***	0.0016	-0.0119***	-0.0097***	-0.0101**	-0.0033*	-0.0077***	-0.0089***	-0.0196***	-0.0015	-0.0087**	-0.0066
	(-6.64)	(0.32)	(-4.49)	(-5.40)	(-2.40)	(-1.95)	(-5.38)	(-3.87)	(-4.18)	(-0.82)	(-2.58)	(-1.34)
$RTRN_{-1}$	0.0009	-0.0072**	0.0011	-0.0024	-0.0065	0.0000	-0.0054***	0.0005	0.0031	0.0004	-0.0009	-0.0029
	(1.30)	(-2.43)	(0.72)	(-0.73)	(-1.38)	(0.04)	(-3.93)	(0.52)	(0.82)	(0.14)	(-0.39)	(-1.20)
$WGDP_{-1}$	0.0010***	-0.0005	0.0019***	-0.0000	0.0006	0.0005**	0.0000	0.0014***	0.0034	0.0029***	0.0019*	-0.0033**
	(4.08)	(-0.50)	(2.98)	(-0.05)	(0.50)	(2.01)	(0.12)	(4.35)	(1.63)	(3.56)	(2.00)	(-2.49)
$HGDP_{-1}$	0.0004**	0.0021**	-0.0000	0.0005	-0.0001	0.0000	0.0002	0.0003	-0.0008	-0.0007	-0.0007	0.0020***
	(2.44)	(2.22)	(-0.09)	(1.19)	(-0.11)	(0.05)	(0.89)	(1.33)	(-0.37)	(-1.29)	(-0.97)	(2.73)
constant	0.1868***	0.0024	0.2603***	0.2056***	0.2631***	0.0659*	0.1564***	0.1841***	0.3234***	0.0627*	0.2084***	0.1964*
	(8.49)	(0.03)	(5.69)	(6.78)	(3.58)	(1.95)	(6.30)	(4.77)	(4.29)	(1.95)	(3.56)	(1.97)
Obs	15751	1139	2801	1215	810	1538	1489	2909	771	1410	690	979
R^2	0.061	0.096	0.106	0.160	0.248	0.092	0.126	0.066	0.195	0.092	0.078	0.090

Note: The significance level is shown by ***, **, *, to denote respectively 1%, 5%, and 10% significance level.

Table 6: Overinvestment Analysis - Combined Score

Dependent Variable = $OVIT_{i,t}$

Variable	Full Sample	Basic Materials	Cons Discret	Cons Staple	Energy	Financials	Health Care	Industrials	Real Estate	Technology	Telecom	Utilities
β_1	-0.0006*	-0.0007	-0.0005	0.0005	-0.0026**	-0.0000	0.0010	-0.0003	-0.0027	0.0009	-0.0011	-0.0032**
	(-1.95)	(-0.71)	(-0.54)	(0.46)	(-2.50)	(-0.09)	(1.05)	(-0.49)	(-1.49)	(0.89)	(-1.02)	(-2.29)
β_2	0.0000	-0.0010	-0.0003	0.0001	0.0004	-0.0000	0.0004	0.0001	-0.0013	0.0009	0.0001	0.0010
	(0.01)	(-1.02)	(-0.57)	(0.13)	(0.43)	(-0.06)	(0.49)	(0.26)	(-0.98)	(1.35)	(0.12)	(1.07)
$COMM_{-1}$	0.3622***	-0.0719	0.2439	0.3048	1.6106***	-0.0254	0.0268	0.5999***	0.3079	0.6237**	0.0577	0.6850*
	(4.25)	(-0.17)	(1.02)	(1.03)	(3.61)	(-0.21)	(0.12)	(3.37)	(0.57)	(2.26)	(0.19)	(1.91)
$WGDP_{-1}$	-0.0082***	-0.0168	0.0008	-0.0266*	0.0019	0.0003	-0.0140*	-0.0067	-0.0028	-0.0032	-0.0096	-0.0462**
	(-2.97)	(-1.27)	(0.13)	(-1.99)	(0.17)	(0.07)	(-1.76)	(-1.39)	(-0.16)	(-0.33)	(-1.02)	(-2.12)
$HGDP_{-1}$	0.0009	0.0181**	-0.0016	0.0067	-0.0232**	-0.0038*	-0.0017	0.0012	0.0083	0.0020	-0.0047	0.0235
	(0.60)	(2.21)	(-0.46)	(1.11)	(-2.19)	(-1.66)	(-0.49)	(0.57)	(0.50)	(0.40)	(-0.80)	(1.28)
$GEPU_{-1}$	-0.0474***	-0.0111	-0.0098	-0.1060**	-0.2333***	0.0273	-0.0102	-0.0560**	-0.1354*	-0.0488	-0.0316	-0.0802
	(-3.97)	(-0.22)	(-0.35)	(-2.01)	(-4.07)	(1.49)	(-0.25)	(-2.07)	(-1.86)	(-1.19)	(-0.67)	(-1.50)
WGI_{-1}	-0.1100*	-0.1399	-0.1408	-0.0719	0.1351	-0.2810*	-0.0370	-0.1845	0.1018	-0.1278	0.1793	-0.1944
	(-1.88)	(-0.85)	(-0.94)	(-0.29)	(0.50)	(-1.87)	(-0.16)	(-1.43)	(0.20)	(-0.70)	(1.56)	(-0.61)
$INFL_{-1}$	0.0145***	0.0206	0.0100	0.0142	0.0324***	0.0038	0.0050	0.0142**	0.0386**	0.0108	0.0106	0.0302**
	(4.87)	(1.62)	(1.19)	(0.98)	(3.12)	(0.80)	(0.53)	(2.53)	(2.18)	(0.91)	(0.85)	(2.15)
constant	0.5052***	0.4883*	0.3635	0.8387*	2.0686***	-0.4276	0.1781	0.3416	1.2437	0.3338	1.1556***	0.9554**
	(5.43)	(1.90)	(1.64)	(1.91)	(5.34)	(-1.56)	(0.42)	(1.55)	(1.63)	(1.51)	(3.67)	(2.03)
N	13371	943	2344	1024	711	1377	1210	2538	631	1136	587	870
R^2	0.006	0.014	0.003	0.018	0.074	0.019	0.008	0.013	0.034	0.013	0.020	0.041

Note: The significance level is shown by ***, **, *, to denote respectively 1%, 5%, and 10% significance level.

Table 7: Overinvestment Analysis - ESG Scores Pillars

Dependent Variable = $OVIT_{i,t}$

Variable	Full Sample	Basic Materials	Cons Discret	Cons Staple	Energy	Financials	Health Care	Industrials	Real Estate	Technology	Telecom	Utilities
Environmental												
β_1	-0.0000	0.0006	-0.0007	0.0004	-0.0043***	0.0000	0.0009	0.0008	-0.0023	0.0008	-0.0015	0.0006
	(-0.05)	(0.46)	(-0.74)	(0.27)	(-2.97)	(0.08)	(0.92)	(1.24)	(-1.06)	(0.72)	(-0.93)	(0.42)
β_2	0.0004	0.0007	-0.0005	0.0001	-0.0014	-0.0000	0.0002	0.0010	-0.0012	0.0007	-0.0005	0.0036**
	(1.38)	(0.54)	(-0.64)	(0.12)	(-1.17)	(-0.01)	(0.23)	(1.59)	(-0.61)	(1.44)	(-0.30)	(2.58)
N	13366	943	2344	1024	711	1377	1210	2538	631	1131	587	870
R^2	0.007	0.013	0.003	0.018	0.082	0.019	0.008	0.015	0.034	0.012	0.023	0.048
Social												
β_1	0.0011***	0.0007	0.0016*	0.0020	0.0019	0.0005	0.0004	0.0006	-0.0016	0.0005	0.0027**	0.0035*
	(3.60)	(0.62)	(1.83)	(1.41)	(1.26)	(1.15)	(0.54)	(0.81)	(-0.95)	(0.76)	(2.29)	(1.91)
β_2	0.0009***	0.0002	0.0016*	0.0012	-0.0000	0.0008	0.0007	0.0004	-0.0009	0.0010	0.0031**	0.0025
	(3.02)	(0.19)	(1.90)	(0.94)	(-0.02)	(1.42)	(0.93)	(0.59)	(-0.58)	(1.60)	(2.25)	(1.24)
N	13366	943	2344	1024	711	1377	1210	2538	631	1131	587	870
R^2	0.008	0.014	0.007	0.025	0.089	0.024	0.008	0.014	0.034	0.014	0.036	0.026
Corporate Governance												
β_1	-0.0006**	-0.0013	-0.0007	0.0006	-0.0019	0.0002	0.0005	-0.0005	-0.0020	0.0008	-0.0002	-0.0015
	(-2.08)	(-1.23)	(-1.08)	(0.58)	(-1.35)	(0.40)	(0.53)	(-0.82)	(-1.09)	(0.80)	(-0.22)	(-0.85)
β_2	0.0000	-0.0014	-0.0006	0.0006	0.0011	0.0001	-0.0000	-0.0002	-0.0009	0.0010	0.0009	0.0026*
	(0.03)	(-1.29)	(-1.12)	(0.53)	(0.79)	(0.47)	(-0.03)	(-0.56)	(-0.73)	(1.27)	(0.80)	(1.77)
N	13371	943	2344	1024	711	1377	1210	2538	631	1136	587	870
R^2	0.007	0.016	0.004	0.019	0.082	0.020	0.008	0.013	0.033	0.014	0.024	0.059
Controversies												
β_1	-0.0008***	-0.0003	-0.0004	-0.0003	-0.0028**	-0.0003	0.0002	-0.0007	-0.0014	0.0003	-0.0011	-0.0052***
	(-3.37)	(-0.31)	(-0.63)	(-0.29)	(-2.10)	(-0.87)	(0.26)	(-1.28)	(-1.16)	(0.52)	(-1.39)	(-3.76)
β_2	-0.0001	-0.0007	-0.0000	-0.0006	0.0001	-0.0003*	-0.0002	-0.0001	0.0004	0.0005	0.0002	-0.0001
	(-1.09)	(-0.99)	(-0.11)	(-1.21)	(0.28)	(-1.92)	(-0.55)	(-0.40)	(0.56)	(0.96)	(0.39)	(-0.23)
N	13366	943	2344	1024	711	1377	1210	2538	631	1131	587	870
R^2	0.007	0.014	0.003	0.020	0.072	0.022	0.007	0.014	0.034	0.012	0.021	0.055

Note: The significance level is shown by ***, **, *, to denote respectively 1%, 5%, and 10% significance level.