

Analyst Attention and Corporate ESG Score: The Mediating Role of Voluntary ESG Information Disclosure

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Abstract

The corporate ESG score is often considered a proxy for competitiveness as it helps attract capital and investors. The study aims to empirically examine the relationship between analyst attention and corporate ESG score by using voluntary ESG information disclosure as a mediating variable. Although many studies have examined various factors that impact ESG scores, the role of voluntary ESG information disclosure has mainly been ignored. This study develops a voluntary ESG information disclosure index with 3 first-level and 37 second-level indicators based on the current ESG information disclosure regulations and ESG rating system in China. Panel data on China Securities Index (CSI 300) non-financial firms from 2015-2019 were used in two-way fixed-effects regressions (industry and year). CSI 300 is the barometer of the stock market, comprising 300 constituent stocks across various sectors with substantial market capitalisation and high liquidity from the Shanghai and Shenzhen stock exchanges. Mediation analysis was conducted using the Baron & Kenny (1986) three-step approach, followed by heterogeneity tests by splitting firms into four groups based on media coverage. The results show a significant positive relationship between voluntary ESG information disclosure and ESG score. Analysts' attention partially mediates the relationship: voluntary ESG information disclosure enhances ESG scores by about 35% through greater analyst attention. Further heterogeneity tests reveal that the amount of media coverage does not affect the positive relationship. However, the mediating effect of analyst attention is only significant among firms that receive "substantial" media coverage. The results have important implications for relevant government policy-makers, ESG rating agencies, firms, investors, and many others.

Keywords: *analyst attention, mediating, voluntary ESG information disclosure, sustainability, competitiveness*

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1 INTRODUCTION

In recent years, investors have become more concerned about global issues such as resource scarcity, stakeholder rights protection, and climate crisis in their decision-making. The United Nations issued the Principles for Socially Responsible Investment in 2006, hoping global investors would consider environmental, social, and governance (ESG) issues in investment decisions to enable sustainability and competitiveness. Unlike the traditional financial performance evaluation, The ESG concept integrates non-financial factors of environment, society, and corporate governance. It assesses firms' sustainable competitiveness from the perspective of long-term profitability to provide a comprehensive score, promoting the sustainable development of society and the economy and facilitating firms to better fulfil their social responsibilities (Kim & Li, 2021). Firms should incorporate ESG factors into their daily business activities that align with corporate social responsibility (CSR). In recent years, as the

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concept of sustainable development has gained increasing attention (Akberdina et al., 2024), integrating ESG concepts, such as environmental performance, into investors' investment decisions has also become more popular in the capital market (Ragazou et al., 2022).

Since their inception, ESG investment strategies have seemed to be relevant only for institutional investors. On the one hand, institutional investors can deal with a massive amount of ESG information. Taking Morgan Stanley Capital International's (MSCI) ESG rating system as an example, after stratifying environmental, social and corporate governance aspects, it comes up with more than 1,000 underlying indicators, covering various data such as corporate risks, operational conditions, internal controls, etc., and then gives each underlying indicator a different weighting, which is then summed up to obtain a composite score. If an institutional investor questions the ESG information provided by an ESG rating agency, the information can be modified after discussing it with the ESG rating agency. Individual investors can only refer to the comprehensive ESG scores provided by ESG rating agencies and are unable to assess firm performance in various aspects, which is not conducive to investors' judgment on the operating conditions of firms. On the other hand, institutional investors pursue long-term returns and are willing to focus on risks of different cycle lengths, including emerging ESG risks. According to Lin and Puchniak (2022), the proportion of professional institutional shareholdings in China only accounted for 18.7 percent, far lower than that in developed regions in Europe and the United States. Individual investors, who account for a larger proportion of the total, cannot assess a firm's sustainability independently, relying heavily on ESG scores provided by ESG rating agencies. ESG rating agencies collect information from the public as well as directly from a firm, and use a comprehensive and complex methodology to calculate the corporate ESG score. Drempetic et al. (2020) point out that in contrast to traditional credit ratings, ESG ratings are mainly "active ratings," i.e., firms provide ESG information to ESG rating agencies, for example, by publishing ESG reports and completing questionnaires. On this basis, firms do not pay fees to ESG rating agencies. As ESG rating agencies rely too much on the information released by firms, the amount of information obtained is too small to support an ESG assessment, and the quality of the ESG information provided is poor (Aouadi & Marsat, 2018).

What exactly ESG rating agencies have measured for calculating ESG scores has not been widely discussed. However, as more and more investors draw on ESG scores provided by ESG rating agencies, some academic studies have recently begun to explore the authenticity and reliability of ESG scores provided by rating agencies. A review of previous studies shows that ESG rating agencies are affected by many factors when assessing corporate sustainability, such as the ESG rating agency's own information integration system, the rating criteria, and the identity of the ESG assessor, etc. Schaltegger and Hörisch (2017) pointed out that based on ESG reports already provided by firms, the firms do not usually provide ESG reports to the ESG rating agencies or other external publics beyond what is required by law. However, based on profit orientation, to enhance the firm's reputation and thus achieve better financial performance, firms voluntarily disclose more ESG information, e.g., communicate sustainability reporting standards to external stakeholders to increase their market value (Lewis, 2003). The current voluntary disclosure of ESG information by firms has become the primary source of information acquisition for ESG rating agencies, which must significantly impact firms' ESG scores. Chatterji et al. (2016) concluded that if ESG scores reflect the efforts made by firms' management to reduce negative ESG news and increase positive ESG news, then positive ESG news should significantly improve the firms' ESG score. If ESG ratings do not reflect the efforts and results made by firm management, then the ESG ratings provided by these

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ESG rating agencies are invalid.

These studies initially suggest that firms' ESG scores are influenced by some fundamental characteristics, such as ESG disclosure accessibility and ESG events, and are also affected by external factors, such as rating agencies' information integration capabilities and assessment criteria. However, these studies have often focused on developed economies since firms in emerging economies often face unfavorable business environments, imperfect corporate governance systems, higher levels of internal corruption, and greater political risk. Few studies have explored the factors affecting corporate ESG ratings in China partly because China's ESG rating agencies are still in the exploratory stage due to their relatively short development time. In addition, China does not yet have a mandatory requirement for corporate ESG disclosure, which makes it impossible for professional organizations to collect and consolidate the required ESG information data. Meanwhile, past research on analysts has mainly focused on the role of analysts as information intermediaries and external supervisors, emphasizing the role of analysts in mitigating information asymmetry and supervising management, or examining the impact of ESG factors on the accuracy and coverage of analysts' forecasts. However, as an essential external governance mechanism, analyst attention can greatly influence market participants. Does analyst attention affect firms' ESG scores? Moreover, what are the mechanisms by which analyst attention is influenced? These are questions to be addressed in this study.

In this study, we first conducted a literature review on ESG disclosure, analysts' attention, and ESG ratings to discuss the theoretical basis and develop research hypotheses for this study. The constituent firms of China's CSI 300 index from 2015-2019 are selected as the research data. Corporate ESG information is collected based on the data released by the firms as well as the China Stock Market & Accounting Research (CSMAR) Database. According to the China-specific voluntary disclosure requirements of ESG information, a self-constructed ESG voluntary disclosure index measures the corporate ESG information disclosure level. Based on the stepwise regression method of Baron and Kenny et al. (1986), the analysis verifies whether firms' ESG scores are affected by analysts' attention and the mediating role of voluntary ESG information disclosure on the relationship between analysts' attention and firms' ESG scores. It also verifies whether ESG rating agencies are influenced by the amount of ESG information disclosed when measuring firms' ESG performance.

The main contributions of this study are twofold. (1) There is a lack of empirical research examining external factors affecting firms' ESG scores. This study takes analyst attention as the dependent variable to explore whether analysts who play the roles of information mediation and external governance can facilitate firms to obtain higher ESG scores; (2) without considering information content, this study takes the perspective of voluntary ESG information disclosure and finds that when firms disclose more ESG information, regardless of whether this ESG information is positive or negative news, it is beneficial for the firms to obtain better ESG scores. However, higher information disclosure does not necessarily mean firms are more sustainable. This further expands the relevant research on the factors affecting corporate ESG ratings and provides new ideas for investors and academics to explore and study ESG ratings. It enables investors to understand that ESG rating agencies may not be genuinely measuring a firm's sustainability and whether rating agencies are simply providing as much information as corporate ESG reports when conducting ESG ratings without reducing the asymmetric distribution of information investors have.

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The study is organized as follows. The first section is the introduction part. Theoretical background is given in the second section to define and discuss the key terms and theories in the topic area. Section three introduces the research objective and research data and develops hypotheses. Results and discussions are presented in the fourth section. The last section is the conclusion which summarizes the research results and outlines future research directions.

2 THEORETICAL BACKGROUND

2.1 Analyst Attention

The extent of firms' disclosure affects analysts' behavior. Many studies have shown that the disclosure of quantitative or qualitative information, such as R&D investment and corporate risk, affects analyst attention and the accuracy of analysts' surplus forecasts (Gu, 2024; He et al., 2024; Hope et al. 2016; Kravet & Muslu, 2013; Merkley, 2014). He (2021) found that when Chinese listed firms publicly disclose information on core competitiveness, the firms' disclosure is not comprehensive and precise, and the incremental information is small, mainly because a large portion of the information disclosed each year is repetitive and of low value. On the other hand, analysts have long had a clear understanding of the firm's core competence, resulting in the disclosure of core competence information having basically no significant impact on analysts' surplus forecast. According to the signaling theory, the management's disclosure of dividend payout policy based on internal information and its own judgment is one of the signals by the management to convey the future earnings expectation of the firm. However, ordinary investors cannot obtain internal information about the firm. They can only assess the firm's operation status through the standard information published by the firm, so analysts will examine the actual situation through irregular and long-term tracking and convey the firm's operation status to external investors through analytical reports. Meanwhile, unlike CSR information, the firms usually do not disclose negative news in ESG information. When there are more and more reports of negative corporate ESG events in the market, firms' business risks increase, leading to reduced analyst attention. For listed firms with a low level of disclosure, analysts' interest in firms' surplus forecasts decreases significantly, resulting in a lower level of analyst attention. In contrast, some listed firms, out of the initial intention of wanting to convey the firm's excellent operating conditions to investors, will actively provide high-quality accounting information to the public, thus attracting a larger number of analyst groups to make surplus forecasts for the firm (Lang & Lundholm, 1996; Yu, 2008). At the same time, analyst attention has a contagion effect. Listed firms with higher analyst attention are more likely to receive attention from external groups such as general investors, professional investment organizations, and the media (Brous & Shane, 1995).

At the same time, analysts are essential in influencing firms' information disclosure policies and supplementing firms' information in the market. First, analysts' published analyses help to supplement firms' non-publicly disclosed information and increase firms' information transparency. Bernardi and Stark (2018) find that price momentum decreases with an increase in analysts, suggesting that analysts increase the speed of diffusion of firm-specific information, thereby reducing information asymmetry. Frankel and Li's (2004) study supports the reduction of asymmetric information provided by analyst tracking by showing that the profitability of insider trading decreases with an increase in analyst tracking. Roulstone (2003) points out that equity analysts' analytical reports not only assess the current stage of a firm's operations and issue surplus forecasts but also increase the information content of the firms in the market, which provides more public information than private information. For seller-side analysts, they usually provide external investors with information about the firms they research, helping investors to understand the real operating conditions of the firms now and the opportunities and

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challenges that may arise in the future. Mola and Guidolin's (2009) study also suggests that for stocks with a particular share of the returns, analysts will be biased towards optimism in the analytical reports they issue on the stock. Second, as external monitors, analysts' concerns can pressure firms' management to improve management's disclosure policy. Suppose the analysts' published analytical reports contain negative news about the listed firms. In that case, they will send unfavorable signals to the outside world, negatively affecting the reputation of the firms, which is not good for the firms' future business activities and capital market operations. The study by Hilary and Hsu (2013) suggests that, due to the increasing demand for analysts' surplus forecasts, the academia has started to show interest in how analyst forecasting characteristics affect pricing mechanisms and analyst career development. Among other things, the validity of analysts' analytical reports should be judged not on the accuracy of their price forecasts but on the informativeness of their forecasts. This is because analysts may introduce downward bias in their forecasts to help management outperform those forecasts. By doing this, analysts can ingratiate themselves with managers and thus gain better access to management information.

Current research on the relationship between analysts and ESG mainly focuses on the impact of ESG scores or ESG events on analyst attention and forecast accuracy. At the same time, there are fewer studies on how analysts affect firms' ESG scores. However, the literature shows that when a firm receives higher analyst attention, it often means that its business condition does not have major problems or even outperforms other firms. Bernardi and Stark (2018) found that when some over-optimistic analysts overestimate the future growth of a firm's surplus, the firm's stock price and financing activities will be adversely affected. Lang et al. (2004) proved that analyst-attended firms generally have sound internal governance mechanisms and are prone to a good reputation in the market, which further attracts analysts' attention. Moreover, managers will run the business better under greater external regulatory pressure to further promote long-term development so that firms with higher analyst attention can achieve better performance in terms of sustainable development. Analysts can not only reduce information asymmetry but also bring benefits to the firms themselves, such as lowering their financing costs and improving their financial performance, by monitoring the firms' business behavior, improving the firms' information environment, and restraining the firms' management (Wang & Hao, 2022). Bradley et al. (2017) found that analyst focus helps to increase the value of cash holdings, the value of acquired assets, and management's surplus management of listed firms and can significantly reduce excessive self-motivation of corporate executives. Asquith et al. (2002) state that when analysts release an analyst report, the market's reaction has a significant positive relationship with the surplus forecasts and the target price forecasts of the stock in the analyst report, with about 54% of the forecasted stock prices being reached within 12 months.

2.2 ESG Information Disclosure

In order to help investors better incorporate ESG concepts into their investment analyses and decision-making processes and promote ESG concepts' development better globally, government authorities and regulators in various countries have successively formulated relevant policies to promote and regulate ESG information disclosure by listed firms. The U.S. Securities and Exchange Commission (SEC) first made regulations on ESG information disclosure in 2010, and the "Guidance on Disclosure of Climate Change-Related Issues" requires all firms listed in the U.S. to disclose environmental information per this regulation. In 2019, it adopted the ESG Reporting Guidelines 2.0 to provide listed firms with the latest ESG reporting system, which is conducive to their understanding and mastering the disclosure forms and measurement methods of various ESG indicators. In 2022, the U.S. SEC made certain modifications based on the global ESG disclosure guidelines. In 2024 SEC officially adopted a

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number of rules to enhance climate-related disclosures by public companies (SEC, 2024). In EU, there are comprehensive ESG regulations implemented and being implemented in the near future. Some of the most critical ESG and non-financial reporting regulations in the EU include Sustainable Finance Disclosure Regulation (SFDR), Corporate Sustainability Reporting Directive (CSRD), Corporate Sustainability Due Diligence Directive (CSDDD), Carbon Border Adjustment Mechanism (CBAM), EU Taxonomy, 'Fit for 55' Package. Each has its own requirements and implementation plan (Plan A, 2024).

In China, ESG disclosure started late and has more room for improvement. Currently, most of China's ESG disclosure requirements are "voluntary" in nature, with less mandatory disclosure. Compared with the U.S. and EU, the development of China's ESG disclosure requirements is based on environmental information, which can be traced back to the "Measures for Disclosure of Environmental Information (for Trial Implementation)" issued by the State Environmental Protection Administration (SEPA) in April 2007, which for the first time encouraged China's large-scale firms to disclose environmental information, but did not detail the requirements for environmental information disclosure. The Securities and Futures Commission (SFC) issued the "Guidelines on the Governance of Listed Firms" in 2018, encouraging listed firms to disclose more about environmental and social responsibility. For ESG disclosure, the "No. 2 Guidelines for the Application of Self-Regulatory Rules for Listed Firms on the Science and Technology Innovation Board of the Shanghai Stock Exchange - Voluntary Disclosure of Information" issued in September 2020 for the first time added this element of corporate governance, which stipulates that listed firms are required to make voluntary disclosure of information in respect of ESG based on their business model and industry characteristics. This requirement is only for firms listed on the Technology Innovation Board of the Shanghai Stock Exchange and cannot be imposed on all firms listed in China. Starting in 2021, the development of ESG disclosure regulations in China has accelerated significantly, but it still largely follows the voluntary principle, with lax oversight. Over the last ten years, the percentage of China's A-share listed firms publishing ESG reports has ranged from 22.6% to 26.9%, and the listed firms that have disclosed ESG reports are mainly banks and heavy-polluting firms. In 2024, China released national ESG reporting guidelines which require big firms to disclose their sustainability performance by 2026. The national ESG reporting guidelines require "businesses to balance global ESG integration with China's priorities, improve data accuracy, foster collaborative approaches, and anticipate growing consumer expectations" (BSR, 2024).

Research on ESG disclosure is very often part of corporate social responsibility. Previous studies have mainly focused on developed regions such as Europe and the U.S. (Brooks & Oikonomou, 2018). Reber et al. (2022) found that ESG disclosure encompasses a wide range of factors related to sustainability that are not usually captured in traditional investment reports and analyses. Currently, there is no consensus among academia on the relationship between ESG disclosure and corporate sustainability. On the one hand, ESG disclosure is beneficial to the future development of firms, and firms will spontaneously disclose more ESG information. Cahan et al. (2015) found that firms with higher ESG performance publish ESG reports to advertise their corporate sustainability capabilities and obtain lower financing costs and higher corporate valuations due to media coverage. Lagasio and Cucari (2019) found that management enhances the level of corporate ESG disclosure in response to the challenges of the external environment as institutional and individual investors realize that firms' ESG scores will reflect the opportunities and risks that firms are currently facing or will face in the future. Reber et al. (2022) state that ESG disclosure responds to stakeholders by enhancing the responsibility of the corporate stakeholders' claims and strategically prevents damage to the firm caused by

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substandard disclosure, such as loss of reputation and brand value, sustainability risks, and risks of financial distress, thus maintaining its social recognition in a significant way. On the other hand, ESG information disclosure can increase the burden on firms, which is unfavorable to the development of firms, thus leading to firms with harmful ESG practices reducing the disclosure of corporate ESG information. Chen et al. (2018) pointed out that, from the perspective of the inhibition effect, when the disclosure of the social responsibility report is chosen, the firm's operation cost will increase. The increased level of disclosure may induce herding behavior, thereby reducing market efficiency. This is due to management manipulation of disclosure, leading to greater investor reaction and increased investor attention, but the disclosure does not reflect the actual situation of the firm (Ho et al., 2022). Capelle-Blancard and Petit (2017), by investigating the capital market's reaction to about 33,000 ESG news reports of 100 multinational listed firms, found that firms with ESG negative news decrease market capitalization by about 0.1%, while firms that respond positively to ESG events do not experience any significant change in market capitalization.

For this reason, scholars have conducted much research on the factors affecting corporate ESG information disclosure. Madison and Schiehl (2021) found that publicly published ESG information of listed firms does not necessarily meet the needs of investors well, which is due to the fact that some listed firms do not comply with the ESG information disclosure requirements or interpret the material information with different standards. Corporate governance, especially board composition structure, is important for the disclosure of corporate environmental information, where the diversity of board members is positively correlated. At the same time, studies have shown that firms increasingly report ESG factors (Amel-Zadeh & Serafeim, 2018), while in countries with more substantial professional organizations, firms disclose more information autonomously (Cahan et al., 2015). Higher information disclosure quality is associated with broader analyst coverage and more accurate forecasts (Lang & Lundholm, 1996; Dhaliwal et al., 2012).

There are only a few studies on how ESG scores provided by rating agencies are affected by firms' ESG disclosures. These few studies have focused more on environmental disclosure and CSR disclosure than on ESG disclosure, and there is an even greater lack of research on the relationship between ESG disclosure and ESG scores in developing country contexts (Eng et al., 2021; Gao et al., 2018). Alsayegh et al. (2020) states that Studies on ESG disclosure and ESG performance in developing countries focus on the relationship between a single dimension of ESG, such as environmental aspects and ESG performance. Dremptetic et al. (2020) suggested that the use of ESG scores to measure corporate sustainability favors large firms and that small firms, because of their lack of understanding of the rating rules of the rating agencies, try to avoid disclosing data on indicators with high difficulty coefficients, thus negatively affecting the ESG scores of small firms. Del Giudice and Rigamonti (2020) found that ESG scores rely mainly on the accuracy, transparency and reliability of the rating information, and the source of the information is mainly the information published by listed firms in their reports. Therefore, if the ESG information collected by rating agencies from firms is inaccurate and insufficient, then the ESG scores of the firms are also inaccurate. Ng and Rezaee (2015) pointed out that there is a correlation between the level of corporate ESG disclosure and their ESG scores, with the ESG scores reflecting the sustainability embodied in the firms' daily business activities, while the ESG disclosure level reflects a firm's information transparency. The higher the ESG score, the more willing a company is to disclose ESG information to show that it is more capable of sustainable development. According to the above summary, the release of ESG

information by firms helps ESG rating agencies to obtain a wide range of information about the firms to give a more realistic assessment and improve the ESG scores of the firms.

China's capital market is not as mature as that of developed countries, exhibiting low transparency, high volatility, less investor protection, and inconspicuous disclosure. One of the reasons for this is the late start of ESG disclosure in China, and the existing ESG disclosure regulations are "voluntary" in nature. While there are professional organizations in foreign countries that collect, collate and evaluate voluntary disclosure data, there is no such professional organization in China that evaluates voluntary disclosure, so scholars generally self-construct voluntary disclosure indices to measure the disclosure level of firms. Meanwhile, China's disclosure requirements in the past were mainly focused on CSR reporting, while the requirements for corporate ESG disclosure are quite different from those of previous disclosure requirements. With the basic framework for ESG disclosure established for the first time in the China Securities Regulatory Commission (CSRC)'s revised Guidelines on the Governance of Listed Firms in September 2018, and with mainland China's stock exchanges having formulated draft guidelines on ESG disclosure and entering the consultation stage. In 2022 China's ESG disclosure requirements were further defined. In 2024, China released national ESG reporting guidelines which require big firms to disclose their sustainability performance by 2026.

2.3 ESG Scores

Clément et al. (2023) did a comprehensive review on ESG scores in the academic literature. The first studies on ESG scores focused on the impact of ESG scores on firms' financial performance. Eccles et al. (2014) found that ESG scores, as an important pillar of CSR performance, facilitate firms to develop sustainable strategies, which in turn affects the financial performance of multinational firms. However, Atan et al. (2018) found that ESG scores could not significantly influence firms' financial performance levels. Limkriangkrai et al. (2017) investigated the relationship between corporate social responsibility and financial performance level in terms of environmental, social responsibility, and corporate governance aspects of ESG, respectively, and found that the three ESG factors do not affect the financial performance level to the same extent. Sachin and Rajesh (2022) investigated whether the practice of ESG concepts by firms contributes to the realization of financial benefits and competitive advantages but failed to find any significant relationship between ESG scores and financial performance and concluded that ESG scores do not provide short-term benefits. On the other hand, Li et al. (2015) pointed out that as a comprehensive evaluation system covering environmental responsibility, social responsibility, and corporate governance, ESG can motivate firms to increase their investment in innovation, reduce agency costs, and lower corporate financing costs. Kim and Li (2021) found that ESG variables usually positively impact credit ratings, with social factors having the most significant effect on credit ratings. However, environmental scores have a surprisingly negative impact. Brooks and Oikonomou (2018) provided an overview of the research examining the impact of ESG information disclosure and the impact of ESG performance on firm value in an extensive literature review. Although evidence on the impact of ESG aspects on firm value is mixed, most evidence suggests a non-negative relationship. The study concludes that ESG information disclosure is usually associated with good ESG performance and higher firm value.

Scholars studying the correlation between firms' ESG scores and investment returns have not yet reached a consistent result and the studies are mainly focused on mature markets. Dimson et al. (2020) found that investors are less likely to achieve higher investment returns from portfolios based on ESG scores when using ESG concepts alone in making investment decisions.

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While listed firms with better ESG scores can achieve better stock returns in the future, stock outperformance has declined in recent years. Because of the significant differences between corporate ESG scores provided by different ESG rating agencies, many studies have begun to explore the various factors that influence corporate ESG scores. Some studies have shown no evidence that the size of a firm's assets affects the evaluation of its CSR activities (Blombäck & Wigren, 2009). However, some researchers pointed out that larger asset size performs better in terms of CSR communication and organizations usually take into account a firm's asset size when assessing its sustainability capabilities, which leads to higher ratings for firms with more considerable assets (Lewis, 2003). Since ESG scores are based on firms' performance in equal proportions in three factors, firms can engage in individual E, S, and G activities at different levels (Humphrey et al., 2012). For example, firms in the Latin American region choose to improve social responsibility and enhance relationships with stakeholders, but lack effective environmental protection monitoring or corporate governance. Cookson and Niessner (2020) found that inconsistencies in ESG scores provided by ESG scoring agencies, due to the existence of different systems of integrating information and criteria for rating information among the rating agencies, indicate that Firms' disclosure policies with respect to ESG naturally affect ESG scores. When firms lack disclosure for certain aspects of information, ESG scoring agencies use rules of thumb to assess firms to achieve consistency in terms of internal ESG scoring agencies (Amel-Zadeh & Serafeim, 2018). For example, when there is a lack of disclosure about a broad and important issue in a particular industry, ESG rating agencies consider this a lousy attribute and negatively assess the firm's performance in that area, thus rating below the industry average. Christensen et al. (2022) pointed out that, unlike financial disclosure, despite extensive ESG disclosure by firms, ESG scorers still need to judge whether the information represents good business conditions. For example, suppose a firm discloses its injury rate. In that case, ESG raters need to judge how good the indicator is, but this is subjective and leads to divergence in the assessments of different ESG raters. This divergence is mainly driven by the disclosure of environmental and social responsibility information, while corporate governance information does not have a significant impact on this. Martiny et al. (2024) did a comprehensive literature review on determinants of ESG performance. They concluded that methods for ESG ratings are extremely fragmented and they call for a more transparent ESG rating.

Although much research is done on the various topics concerning analyst attention, media coverage, information disclosure, and ESG scores. However, little research is done on the interaction between these variables. This study aims to integrate these important factors by using voluntary ESG information disclosure as a mediator to study the relationship of analyst attention and ESG scores. The role of media coverage is also examined in the relationship.

3 RESEARCH OBJECTIVE, HYPOTHESES DEVELOPMENT AND DATA

This study aims to verify whether firms' ESG scores are affected by analysts' attention and to study the mediating role of voluntary ESG information disclosure in the relationship between analysts' attention and firms' ESG scores. It also investigates whether ESG rating agencies are influenced by the amount of ESG information disclosed by firms when measuring firms' ESG performance.

3.1 Hypotheses Development

Analyst Attention and ESG Score

Analysts are professionals who develop unique firm-level and industry-level insights in gathering and evaluating financial, operational, and competitive information about firms, which

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can be valuable to investors and management (Brown et al., 2015). Analysts will often pay more attention to firms with abnormal operations. Wang et al. (2018) found that although some firms have a high risk of stock price collapse, these firms are more likely to incur stock price increases due to asymmetric disclosure of good news on operations. Investors cannot professionally judge the root cause of the increase in stock price, so analysts prefer to study listed firms with a higher risk of stock price collapse. However, many studies have found that analysts' attention is closely related to the firm's business activities, and analysts will pay more attention to good firms and less to firms with deteriorating business conditions. This is because in order to avoid investors from mistakenly selecting those listed firms with abnormal behaviors, analysts have greater incentives to exclude information landmines for investors, which serves as a disincentive to corporate irregularities.

In addition, Dremptetic et al. (2020) found that there is a high degree of association between the degree of ESG information availability and firms' ESG scores. Firms with more ESG information disclosure receive higher ESG scores. Based on the limited attention theory, investors will not have unlimited attention and investors' attention is scarce. Then, ESG rating agencies will also have some cognitive biases as investors. That is, ESG rating agencies cannot assess all the information appearing in the market, and analysts study a large number of firms that usually have more information sources for reference than ESG rating agencies. ESG rating agencies are more able to get a professional analysis of the business situation of a firm, which has become a consistent choice of ESG rating agencies. Based on the above research, this study proposes the following hypothesis:

H1: Firms have higher ESG scores when they receive more analyst attention.

Analyst Attention and ESG Disclosure

Analyst attention means that listed firms will receive long-term tracking and occasional inspection by securities analysts, which has a supervisory effect on management. For risk avoidance, under the deterrence of analysts' attention, major shareholders and management will curb their own tendency to violate the law, and then the firm's operation will be standardized (Yu, 2008). Analysts are believed to act as a substitute for regulators and boards of directors and are far more efficient than regulators and certified public accountants in exposing accounting fraud in fraudulent firms (Dyck et al., 2008; Sun & Liu, 2016). Huang et al. (2020) stated that analyst networks influence firms' disclosure policies by influencing the firm's information environment. As analysts' power increases, analyst networks' influence on corporate disclosure policies is more significant. The legitimacy theory suggests that firms must be socially accepted to thrive (Guthrie & Parker, 1989). In order to avoid the influence of relevant negative news and maintain a good reputation, the management of listed firms that are concerned by analysts will disclose information about the environment, products, community contribution, human resources, etc., and endeavor to improve the transparency of information (Hahn & Kühnen, 2013). Chang et al. (2006) found that compared with ordinary investors, analysts are more professional and interpret the information disclosed by listed firms more thoroughly, especially for non-professional investors. The information interpreted by analysts is more explicit so that they can make better investment decisions. This helps form a monitoring mechanism for the firm's management, prompts the management to regulate their own behavior, strengthens the firm's internal governance, and improves the quality of information disclosure. With analyst attention, the cost of violation and the risk of punishment of listed firms have increased significantly, and it is difficult for violations to occur without being detected by the

outside world, thus promoting a significant increase in the transparency of corporate information. Based on the above research, this study proposes the following hypothesis:

H2: Analyst attention promotes firms to disclose more ESG information.

Analyst Attention, Voluntary Disclosure of ESG Information and ESG Scores

As one of the indicators of business integrity, the level of information disclosure should reflect the degree of information availability, and it is logical for firms to disclose data on the firm's accounting metrics, risk, corporate governance, social responsibility, etc. Elliott and Jacobson (1994) found that the level of disclosure significantly and positively affects a firm's value in the capital market, which is due to the fact that the agency problem is partially mitigated when investors gather more internal information about the firm and investors are more willing to invest their money. When firms want to attract investors to make strategic investments, management voluntarily discloses information about the firm's strategy to partners and outsiders, which is usually credible and can create incentives for investors, thus increasing firm value. At the same time, when management reveals its future strategic intentions, it is subject to more external regulatory pressure from investors, which in turn promotes management's motivation. In order to reduce the agency problem caused by the separation of powers, the shareholders' meeting requires the management to disclose more information to assess the firm's operating conditions and management's behavior, which helps shareholders to comprehensively and objectively assess the manager's work, alleviates the management's professional concerns, and promotes the management's investment in innovation and research and development, which ensures the firm's future competitive advantage and facilitates the sustainable development of the firm. Some researchers found that for some developing countries (e.g., China), the mandatory degree of information disclosure and the nature of the firm's equity significantly affect the relationship between the firm's economic performance and the level of environmental information disclosure (Meng et al., 2013). Alsayegh et al. (2020) found that firms' disclosure of ESG information is an essential factor in creating a competitive advantage, where disclosure of the implementation of E and S aspects of the strategy enhances the firm's sustainability performance.

In summary, firms that do better in ESG disclosure will perform better externally in terms of financial performance, social responsibility, and corporate governance compliance. At the same time, because firms selectively reduce the disclosure of negative ESG news, ESG rating agencies will collect more positive news in disguise, and firms will get better ESG scores. The higher the analyst's attention, the better its actual situation can be reflected in the capital market. The higher the transparency of corporate information, the more likely the firm will get a better ESG score. Based on the above research, this study proposes the following hypothesis:

H3: Voluntary disclosure of ESG information mediates the effect between analyst attention and ESG scores.

The hypotheses are illustrated in the following Fig 1.

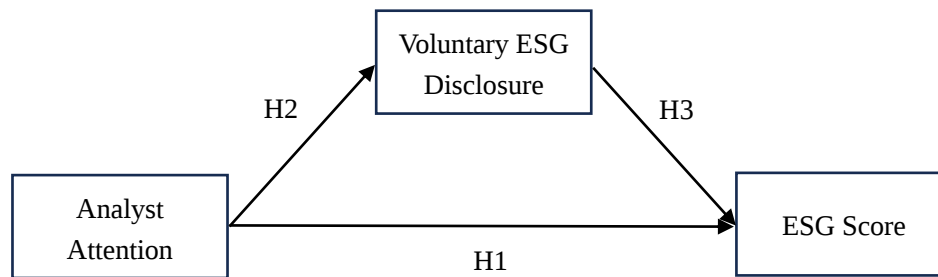


Fig. 1 – Hypotheses Development

3.2 Research Design and Data

Measuring Voluntary Disclosure of ESG Information

Currently, scholars measure the level of voluntary disclosure mainly based on representative financial indicators in annual reports or self-constructed voluntary disclosure indexes. For example, Botosan's (1997) voluntary disclosure index focuses on firms' predictive information and contains five components: background information, historical information, critical non-financial information, predictive information, and management discussion and analysis. The construction of such indexes is highly personal and subjective, and the index system generally contains dozens of indicators. As a result, the system is too large so it is difficult to obtain complete and continuous yearly data.

Since past research has mainly focused on the study of corporate financial information, not on ESG concepts, and not enough attention has been paid to corporate governance and risk control, the disclosure indicators in past academic research are not highly applicable to today's ESG concepts. At the same time, the research is mainly based on scholars outside of China and does not incorporate indicators that fit China's current stage of development, such as precise poverty alleviation planning, carbon emission information, and corporate violations. Regarding professional rating agencies, China's current indicators for information disclosure are mainly assessed in terms of firms' environmental and accounting information, and there are no comprehensive evaluation indicators for voluntary disclosure of ESG information.

This study constructs a new set of voluntary ESG information disclosure indexes based on the studies of Gao et al. (2018), taking into account the shortcomings of the previous studies. It is mainly based on the "Administrative Measures for the Legal Disclosure of Corporate Environmental Information" issued by the Ministry of Ecology and Environment at its fourth ministerial meeting in 2021, and the requirements for ESG information disclosure of listed firms in the "Guidelines on the Content and Format of Information Disclosure by Firms Issuing Securities in Public, No. 2-Content and Format of Annual Reports (Revised in 2021)" in the Announcement of the China Securities Regulatory Commission (CSRC) No. 15 in 2021. The data comes from listed firms' social responsibility reports, the (CSMAR) database, and other public data, and finally forms the voluntary ESG information disclosure index of this study, which includes indicators of Chinese characteristics such as the Precision Support Programme, carbon emissions, etc. The standard is open and transparent and has operational continuity and verifiability. Starting from the three aspects of ESG, this study divides all the voluntary disclosure information of listed firms into three first level indicators: corporate social information, corporate social responsibility information and corporate governance information, and there are a total of 37 collective contents of second level indicators as shown in Tab. 1.

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Tab. 1 – Voluntary ESG information disclosure index: Source: modified from Gao et al. (2018)

Classification	Voluntary Information Disclosure Indicator
Environment	Environmental philosophy Environmental objective Environmental management system Environmental incident response mechanism Amount invested in ecological protection Carbon emission level Pollutant emission compliance Environmental offences ISO9001certified or not
Social Responsibility	Public relations and social welfare Environmental protection and sustainable development Social donations Precision Poverty Alleviation Programme (PPA) Protection of shareholders' rights and interests Creditor rights and interests protection Employee rights and interests protection Supplier rights and interests protection Customer and consumer rights and interests protection Validated by a third-party agency
Corporate Governance	Corporate strategy Future outlook Corporate culture Main products Director appraisal system Corporate governance structure Employee composition Employee training Competitive advantage Innovation R&D Industry position Information disclosure system Difficulties faced by the company Reference to the GRI Guidelines for Sustainability Reporting Attendance rate at general meetings Deficiencies in internal controls Whether corrective measures are taken for internal control Internal control reports

After specifying the index, according to the items disclosed in the CSR report or corporate ESG report of the sample listed firms, if the index is disclosed in the report, this index is scored as 1. If the index is not disclosed in the report, this index is scored as 0. A total score of 37 is assigned to the index, with a minimum of 0. The scores of all the indexes of each firm are then summed up, and the total score is divided by a total score of 37, to get a relative number that facilitates comparison between data from different years, called the voluntary ESG information disclosure index of firms (VDI for short).

Measuring Control Variables

This study will control for the factors affecting the corporate ESG scores based on previous research on ESG ratings (Tab. 2) to prevent the omission of variables from biasing the experimental results.

Tab. 2 – Variable definition and description. Source: own research

Variable	Variable Name	Variable Symbol	Calculation Method
Dependent variable	ESG score	ESG	Corporate ESG scores published by SynTao Green Finance
Independent variable	Analyst attention	Analyst	Ln (Number of analyst teams +1)
Mediator variable	Voluntary ESG information disclosure	VDI	Self-constructed ESG voluntary disclosure index
Control variable	Overseas revenue share	ForeSale	Overseas revenue / Total operating revenue×100%
	Institutional shareholding	InsHold	Total institutional shareholding / A shares in circulation×100%
	Net profit margin on total assets	ROA	Net profit/Average balance of total assets
	Nature of equity	Equity	1=State-owned, 2=Private, 3=Foreign, 4=Other
	Revenue growth rate	Growth	(Amount of operating income for the current year current single quarter - Amount of operating income for the previous single quarter) / (Amount of operating income for the previous single quarter)

The control variables include the proportion of overseas revenue (measured by the percentage of revenue from overseas regions to total operating revenue), institutional shareholding (measured by the ratio of the total number of institutional shareholdings to the total number of shares outstanding), net profit margin on total assets (measured by the ratio of net profit to the average balance of total assets), nature of shareholding (state-owned enterprises = 1, private enterprises = 2, foreign-funded enterprises = 3, and others = 4), and the growth rate of operating revenue (measured by the difference between year-end operating income and beginning operating income as a percentage of beginning operating income).

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Empirical Models

First, to investigate the impact of the corporate voluntary disclosure index and analysts' attention on corporate ESG scores, the p-value is less than 0.01 by the Hausman test of the panel data model, so the random effect is rejected, and the fixed effect model is used for the empirical test. In addition, for all the regression tests involved in this study, a two-way fixed model controlling for "year-industry" is used.

Based on the literature review, this study infers that analyst attention affects firms' ESG scores by influencing the voluntary disclosure of ESG information. Drawing on the stepwise approach to mediation effect testing developed by Baron and Kenny (1986), the mediation effect can be tested in three steps: first, regressing the mediation on the independent variables. Second, the dependent variable is regressed to the independent variable. Third, the dependent variable is regressed to the independent and mediating variables. The independent variable in the first two models is expected to show statistical significance, while the third model is expected to show the mediator's statistical significance. Third, the dependent variable is regressed on the independent variables and the mediator. Suppose all the above conditions are satisfied and the relationship between the independent variable and the dependent variable remains in the presence of the mediating variable. In that case, the mediating effect is partially mediated. Therefore, the following three models were designed based on the previous assumptions:

$$ESG_i = \alpha_0 + \alpha_1 \text{Analyst}_i + \alpha_2 \text{Control}_i + \varepsilon_i \quad (1)$$

$$VDI_{it} = \beta_0 + \beta_1 \text{Analyst}_i + \beta_2 \text{Control}_{it} + \varepsilon_i \quad (2)$$

$$ESG_i = \gamma_0 + \gamma_1 \text{Analyst}_i + \gamma_2 VDI_{it} + \gamma_3 \text{Control}_i + \varepsilon_i \quad (3)$$

Where ESG_i denotes firms' ESG scores in period t . VDI_i denotes the voluntary disclosure index of firms' ESG information in period t . Control_i denotes the set of various control variables in period t . ε_i denotes the random perturbation term.

Research Data

This study collects data on ESG scores, analysts' attention and control variables from the CSMAR database. Due to the lack of standardization of ESG disclosure by listed firms in China, some of the data in the "corporate governance" level of the Voluntary Corporate Disclosure Index come from the social responsibility reports or ESG reports of listed firms, which are manually collected and collated, while the rest of the ESG data come from the Genius database and the CSMAR database. The constituent firms in China's CSI 300 index from 2015-2019 are used as the research sample. The principles of sample selection include the following: first, financial firms whose financial statement structure and major accounting items are different from those of the general industry are excluded; second, "special treatment" (ST) firms and firms with missing core data due to abnormal financial or other conditions are excluded; third, in order to exclude the impact of some extreme values on this study, the data of continuous variables are not included in the sample. Winsorize the data for continuous variables at 1% and 99% levels to shrink the tails. Finally, the data of 381 listed firms with valid samples are obtained.

4 RESULTS AND DISCUSSION

4.1 Descriptive Statistics

The results of descriptive statistics for the total sample are shown in Tab. 3.

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Tab. 3 – Descriptive statistics. Source: own research

Variable	N	Mean	SD	Min	P50	Max
ESG	1248	48.68	5.475	35.13	48	67.63
Analyst	1248	1.190	0.343	0.301	1.255	1.881
VDI	1248	0.530	0.0940	0.132	0.526	0.763
ForeSale	1248	8.689	15.95	-1.680	0.591	100
InsHold	1248	1.782	0.201	0.620	1.839	2.009
ROA	1248	0.05	0.06	-0.73	0.040	0.43
Equity	1248	1.401	0.590	1	1	4
Growth	1248	0.29	0.69	-1.08	0.12	5.91

The mean and median ESG ratings of the study sample in 2015-2019 are 48.68 and 48, respectively, indicating a relatively even distribution of firms' ESG ratings performance. The mean, minimum, median and maximum of firms' voluntary disclosure indexes are 0.53, 0.13, 0.53 and 0.76, respectively. The mean, minimum and maximum of analyst attention are 1.19, 0.30 and 1.88, respectively, corresponding to the number of analyst teams of 0, 18.63 and 75, suggesting big differences in analyst attention for different firms.

4.2 Correlation Analysis

Tab. 4 – Pearson's correlation coefficient. Source: own research

	ESG	Analyst	VDI	ForeSale	InsHold	ROA	Equity	Growth
ESG	1							
Analyst	0.182***	1						
VDI	0.404***	0.169***	1					
ForeSale	-0.058**	-0.0360	0.00100	1				
InsHold	0.073**	0.123***	0.0180	-0.154***	1			
ROA	-0.079***	0.305***	-0.094***	0.0330	0.0230	1		
Equity	-0.066**	-0.0530	-0.0440	0.192***	-0.321***	0.00600	1	
Growth	-0.095***	-0.075***	-0.0190	0.061**	0.016	0.081***	-0.081***	1

Note: ***, **, * denotes significance at 1%, 5% and 10% level, respectively

As shown by the Pearson correlation coefficients in Tab. 4, the independent variable analyst attention, the mediator variable voluntary disclosure of ESG information are all significantly and positively correlated with the dependent variable ESG score at the 1% level, which indicates that when firms have more analyst attention and voluntary disclosure of ESG information, their ESG scores are higher. In addition, analyst attention and voluntary disclosure of ESG information are significantly and positively correlated at the 1% level, indicating that higher analyst attention helps firms disclose more ESG information. In order to exclude the existence of a linear correlation between the independent variables, this study uses the variance inflation factor (VIF) method to test multicollinearity. The regression results found that the range of the VIF values of the independent variables is 1.060-1.370, which are all less than 10, thus ruling out serious multicollinearity problems in this model.

4.3 Testing for Mediation

The mediating effect of voluntary disclosure of ESG information is investigated through the above stepwise regression model, and the results are shown in Tab. 5.

Tab. 5 – Regression analysis for the mediation effect of VDI. Source: own research

Variable	(1) ESG	(2) VDI	(3) ESG
Analyst	3.043***	0.067***	1.965***

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	(5.62)	(6.82)	(3.69)
VDI			16.047***
			(8.91)
ForeSale	-0.028	-0.000	-0.021
	(-0.93)	(-0.78)	(-0.73)
InsHold	29.767**	0.161	27.187**
	(2.19)	(0.65)	(2.09)
ROA	-9.385***	-0.216***	-5.916*
	(-2.97)	(-3.76)	(-1.94)
Equity	4.063***	0.007	3.946***
	(3.26)	(0.32)	(3.30)
Growth	-0.003	-0.000	-0.002
	(-0.83)	(-0.75)	(-0.64)
Constant	26.084***	0.589***	16.637**
	(2.97)	(3.69)	(1.97)
N	1,248	1,248	1,248
R ²	0.066	0.070	0.146
Ind/Year	YES	YES	YES

The result of column (1) shows that the regression coefficient of analyst attention on firms' ESG scores is 3.043 and is significant at 1% level. This indicates that after the firm obtains more analyst attention, the firm's information disclosure and business operation will be more standardized and improved, which will benefit the enhancement of the firm's ESG scores, thus verifying Hypothesis H1. Regarding the control variables, the regression coefficient of the proportion of institutional shareholding is 4.063. It is significant at 1% level, which indicates that the nature of firm shareholding significantly affects the firm's performance of the ESG ratings. However, the social responsibility of SOEs demands higher requirements, not only to focus on the internal operation and development of the firm but also to take into account the rights and demands of all stakeholders and to play an exemplary and pioneering role in fulfilling social responsibility and protecting the environment. Private firms, on the other hand, aim to maximize shareholders' interests and will actively disclose relevant information in response to the government's call for social responsibility. At the same time, foreign shareholders not only bring in more advanced technology and management style but also introduce the concept of social responsibility into listed firms, supervise and improve the disclosure of corporate social responsibility information, which is more beneficial to the firms to obtain a better ESG score. The regression coefficient of institutional shareholding is 29.767 and is significant at the 5% level, indicating that institutional shareholding in firms positively affects ESG rating. The regression coefficient of ROA is -9.385 and is significant at the 1% level, indicating that ROA, which reflects the efficiency of total assets utilization, negatively affects ESG rating. The rest of the factors do not significantly affect firms' ESG score.

The result of column (2) shows that the regression coefficient of analyst attention β_1 is 0.067, significantly positively correlated at the 1% level. This can indicate that when analyst attention increases, forced by analysts' monitoring and facilitating effect, firms will change their ESG disclosure policy to disclose as much ESG information as possible. Therefore, hypothesis H2 is verified to be valid. Column (3) simultaneously tests the voluntary disclosure of ESG information and analyst attention to ESG score. The results show that the regression coefficients γ_1 and γ_2 of analyst attention and voluntary disclosure of ESG information are 1.965 and 16.047, respectively, and are significantly positively correlated at a 1% level, which indicates that the

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significant positive relationship between analyst attention and firms' ESG scores has not been changed. However, the regression coefficient decreases from 3.043 to 1.965, and $\beta_1 \cdot \gamma_2$ and γ_1 have the same sign, indicating significant direct and indirect effects of voluntary disclosure of ESG information in the stepwise test equation. The total effect of analyst attention on corporate ESG scores is 3.043, and the direct effect of analyst attention on corporate ESG scores is 1.965. The indirect effect of analyst attention on corporate ESG scores through voluntary disclosure of ESG information is 1.075, and the indirect effect accounts for 35.33% of the total effect, which verifies that Hypothesis H3 holds.

The results of this study suggest that analyst attention's impact on firms' ESG scores weakens as voluntary disclosure of ESG information increases, but analyst attention can influence voluntary disclosure of ESG information to improve firms' ESG score.

4.4 Heterogeneity Test

Barber and Odean (2008) pointed out that the media not only increases the information content in the market and provides easy access to information for investors but also appropriately attracts investors to buy the shares of the firms. As an information intermediary and external monitor, the media can collect, analyze and publish information to exert pressure on the management of firms, thus improving their corporate governance. The recent study by He et al. (2024) also generated similar results. Firm management is motivated to use correct behavior to avoid the risk of a share price fall caused by negative news in the media. However, negative news released by the media does not pressure management to curb corporate tax aggressiveness, suggesting that the effect of media coverage on firms is not entirely significant (Chen et al., 2018).

To test the validity of this hypothesis mentioned above, this study measured the number of media coverage of the firms by the total number of news stories in which the firm appeared in the headlines, with data from the Genius database. The sample was equally divided into four groups according to the order of the number of media coverage from the smallest to the largest, and the sample size of each group was 312. The division criteria are: the 1st to 312th number of media coverage is categorized as Group 1, the 313th to 624th number of media coverage is categorized as Group 2, the 625th to 936th number of media coverage is categorized as Group 3, and the 937th to 1248th number of media coverage is categorized as Group 4. Stepwise regression tests were again performed on corporate ESG scores with analyst attention as the dependent variable.

Tab. 6 – Group 1 regression analysis for the mediation effect of VDI. Source: own research

Variable	(1) ESG	(2) VDI	(3) ESG
Analyst	2.266 (1.63)	0.080*** (3.48)	0.498 (0.37)
VDI			22.043*** (4.81)
ForeSale	-0.037 (-0.60)	0.001 (0.63)	-0.051 (-0.89)
InsHold	-5.042 (-0.46)	-0.120 (-0.66)	-2.396 (-0.23)
ROA	-10.584	-0.068	-9.089

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	(-1.27)	(-0.49)	(-1.17)
Equity	6.249	-0.022	6.730
	(1.14)	(-0.24)	(1.31)
Growth	0.020	-0.001	0.052
	(0.33)	(-1.41)	(0.90)
Constant	44.505**	0.730*	28.407
	(1.99)	(1.96)	(1.34)
N	1,248	1,248	1,248
R ²	0.062	0.148	0.188
Ind/Year	YES	YES	YES

Tab. 7 – Group 2 regression analysis for the mediation effect of VDI. Source: own research

Variable	(1) ESG	(2) VDI	(3) ESG
Analyst	1.700 (1.29)	0.052** (2.25)	0.792 (0.62)
VDI			17.602*** (4.01)
ForeSale	-0.018 (-0.24)	-0.001 (-1.02)	0.006 (0.08)
InsHold	0.142 (0.02)	0.203 (1.25)	-3.424 (-0.39)
ROA	-14.813* (-1.92)	-0.210 (-1.56)	-11.122 (-1.50)
Equity	6.437 (1.53)	0.124* (1.69)	4.257 (1.05)
Growth	0.023 (0.87)	-0.000 (-0.12)	0.024 (0.95)
Constant	45.943** (2.34)	0.146 (0.43)	43.366** (2.31)
N	1,248	1,248	1,248
R ²	0.113	0.155	0.197
Ind/Year	YES	YES	YES

Tab. 8 – Group 3 regression analysis for the mediation effect of VDI. Source: own research

Variable	(1) ESG	(2) VDI	(3) ESG
Analyst	2.681** (2.32)	0.028 (1.23)	2.286** (2.05)
VDI			14.305*** (3.52)
ForeSale	-0.018 (-0.25)	-0.001 (-0.75)	-0.003 (-0.05)
InsHold	13.990 (1.61)	-0.029 (-0.17)	14.399* (1.72)
ROA	-26.659*** (-2.76)	-0.359* (-1.90)	-21.530** (-2.28)

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Equity	2.880 (1.65)	0.007 (0.20)	2.782* (1.66)
Growth	0.011 (0.52)	-0.001** (-2.05)	0.024 (1.12)
Constant	13.985 (0.77)	0.793** (2.23)	2.644 (0.15)
N	1,248	1,248	1,248
R ²	0.134	0.093	0.201
Ind/Year	YES	YES	YES

Tab. 9 – Group 4 regression analysis for the mediation effect of VDI. Source: own research

Variable	(1) ESG	(2) VDI	(3) ESG
Analyst	5.732*** (5.15)	0.093*** (4.19)	4.615*** (4.09)
VDI			12.058*** (3.51)
ForeSale	0.031 (0.37)	0.001 (0.50)	0.021 (0.26)
InsHold	37.790*** (3.06)	0.124 (0.51)	36.294*** (3.02)
ROA	-27.664*** (-3.91)	-0.457*** (-3.25)	-22.150*** (-3.14)
Equity	10.437*** (3.53)	-0.005 (-0.08)	10.496*** (3.65)
Growth	0.005 (0.21)	-0.000 (-0.39)	0.007 (0.31)
Constant	-46.001* (-1.78)	0.082 (0.16)	-46.993* (-1.87)
N	1,248	1,248	1,248
R ²	0.253	0.131	0.296
Ind/Year	YES	YES	YES

The regression results, as shown in Tab. 6-9, indicate that the significant positive effect of voluntary disclosure of ESG information on firms' ESG scores is not limited by the number of media reports, but the effect of analysts on firms' ESG scores is significantly positive only when the number of media reports is "high." In addition, the mediating effect of voluntary ESG disclosure is affected by the amount of media coverage. This may be because media reports can monitor the behavior of corporate management and regulators after a market transaction contract has been reached, thus affecting corporate performance in the market. Especially when there is significant information asymmetry, the media is more likely to be trusted by investors, which leads to a "media-investor-corporate-governance" transmission, enhancing corporate governance (Dyck et al., 2008), and thus improving market effectiveness. On the other hand, media coverage of listed firms provides stakeholders with more management information and facilitates the rapid dissemination of corporate information (Bushee et al., 2010).

4.5 Robustness Tests

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Ge and McVay (2005) found that larger firms disclose internal control deficiencies significantly less often than smaller firms, suggesting that larger firms have more effective and improved internal controls. Doyle et al. (2007) state that smaller firms disclose their internal control deficiencies more frequently than larger firms. Firms' asset size has a significant positive relationship with environmental information disclosure because firms with large assets are subject to stricter public scrutiny, which leads to the provision of high-quality information systems. Wang et al. (2018) found that large firms can minimize costs and rapidly transform and upgrade through sustainable supply chain management (SSCM), which leads to higher levels of economic, environmental, and social performance. It can be seen that asset size positively affects firms' internal control, disclosure policy, and performance, which helps attract more analysts' attention. According to the external pressure theory, when the asset size of a firm is larger, it will receive more public attention due to the greater impact on various stakeholders. In summary, it can be seen that a firm's asset size can be considered as an exogenous variable that affects analysts' attention and does not affect firms' ESG scores, which can be used as an instrumental variable to solve the endogeneity problem of this study and tested for endogeneity by using the two-stage least squares (2SLS) method.

Tab. 10 – Endogenous test. Source: own research

Variable	First Stage Analyst	Second Stage ESG
Size	1.693*** (0.230)	
Analyst		4.820*** (2.220)
Industry	YES	YES
Year	YES	YES
Control variable	YES	YES
N	1248.000	1248.000
r ²	0.179	

The regression results are shown in Tab. 10, where the regression coefficient of analyst attention and firm asset size in the first stage regression is 1.693 and is significant at the 1% level. The regression coefficient of ESG and analyst attention in the second stage regression is 4.820 and is significant at the 1% level. Both regressions pass the significance test at the same time, indicating that the positive impact of analyst attention on firms' ESG scores remains after controlling for endogeneity issues in this study, and the conclusion remains unchanged. In addition, the weak instrumental variable test on the regression results of the first stage shows that the bias $R^2 = 0.179$, which indicates that the instrumental variable - corporate asset size has strong explanatory power on the endogenous variables. The F-statistic = 54.625 > 10, which is judged according to the empirical criterion that corporate asset size is not a weak variable instrument.

4.6 Bootstrap Test

In order to prevent the biased results caused by the low validity of the stepwise regression method for the mediation effect mechanism, this study used the Bootstrap test, which has a

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higher statistical validity, to re-test the mediation effect of the voluntary disclosure of ESG information. The main procedure is as follows: the sample is sampled 1,000 times with return and gets the estimation of 1,000 coefficients' product, and then confidence intervals are obtained by sorting the estimates according to their size. The regression analysis results show that the confidence interval is [1.2521, 3.4459], and the confidence interval does not contain 0, indicating that the test results of the mediation effect are robust.

4.7 Extreme Data Sensitivity Analysis

To prevent the extreme data from causing bias in the regression results, this study ranks the analysts' attention. Equally divided into four groups, each with a sample size of 312, the analysts are assigned the values 1, 2, 3, and 4 from smallest to largest. Stepwise regression is used to test the mediating effect of voluntary disclosure of ESG information, and the regression results are shown in Tab. 11.

Tab. 11 – Regression analysis for the mediation effect of VDI. Source: own research

Variable	(1) ESG	(2) VDI	(3) ESG
Analyst	0.839*** (4.88)	0.016*** (5.11)	0.574*** (3.45)
VDI			16.513*** (9.28)
ForeSale	-0.029 (-0.94)	-0.001 (-0.93)	-0.020 (-0.69)
InsHold	6.010 (1.41)	-0.043 (-0.56)	6.725* (1.66)
ROA	-8.745*** (-2.75)	-0.188*** (-3.24)	-5.637* (-1.85)
Equity	3.990*** (3.20)	0.006 (0.26)	3.891*** (3.27)
Growth	-0.004 (-0.94)	-0.000 (-1.01)	-0.003 (-0.67)
Constant	31.290*** (4.01)	0.576*** (4.03)	21.780*** (2.90)
N	1,248	1,248	1,248
R ²	0.054	0.047	0.141
Ind/Year	YES	YES	YES

The result of column (2) shows that the regression coefficient of analyst attention is 0.016, which is significantly positively correlated at 1% level. The results of Column (3) show that the regression coefficients γ_1 and γ_2 of analyst attention and voluntary disclosure of ESG information are 0.574 and 16.513, respectively, both of which are significantly and positively correlated at the 1% level, which suggests that some of the mediating effects between analyst attention and firms' ESG scores remain unchanged. Firms with greater analyst attention can still increase voluntary disclosure of ESG information to improve their ESG scores, indicating that the study's results are not biased due to extreme data.

4.8 Discussion

This study highlights the significant role of analyst attention in shaping firms' ESG scores. By measuring analyst attention through the volume of analyst reports, we observe a direct positive

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correlation with ESG scores. This finding underscores the considerable influence analysts wield within capital markets, not only over financial sentiment but also over corporate disclosure practices. Therefore it is imperative for analysts to broaden their focus beyond traditional financial metrics to include non-financial performance indicators such as ethics, social responsibility, and stakeholder rights. By leveraging advanced financial technology analysts can identify diverse risks and provide impartial analyses of corporate sustainability to fostering the growth of exemplary firms and helping investors achieve stable returns.

Our research also reveals a strong link between the level of corporate ESG information disclosure and the ESG scores assigned by rating agencies. Firms that voluntarily disclose more ESG information tend to receive higher scores. This suggests a critical limitation in the current ESG rating landscape: ratings may not fully capture a firm's true sustainability largely due to the varying availability of information. In markets like China, where mandatory ESG disclosure is not yet prevalent, rating agencies may infer poorer performance for firms with limited data leading to lower scores. This can disadvantage firms that struggle with navigating complex ESG disclosure policies or opt for lower-cost disclosure options. As Dremptic et al. (2020) noted, firms become the primary information source for ESG rating agencies which potentially favor those with greater information accessibility. Given these challenges and the global lack of standardized ESG disclosure requirements, it is crucial for firms to proactively focus on comprehensive ESG disclosure to enhance their societal and investor appeal. In addition, national authorities and international organizations should collaborate to establish mandatory, country-specific ESG disclosure guidelines and rating systems to ensure more accurate and consistent assessments of corporate sustainability. Probably open innovation can play a role here to help government authorities to improve sustainability level as well as better ESG disclosure guidelines (Kyriakopoulos, 2023).

This study also uncovers the moderating effect of media reports on the relationship between analyst attention, voluntary ESG disclosure, and ESG scores. Specifically, the impact of analyst attention is more pronounced in firms with “larger” media coverage. This suggests that the combined scrutiny from both media and analysts may prompt firms to enhance their ESG disclosure and practices, ultimately influencing their ESG scores. Interestingly, the positive and significant effect of voluntary ESG disclosure on corporate ESG scores remains robust regardless of the volume of media reports. This finding further reinforces the notion that ESG scores are inherently limited by the quantity of disclosed information and may not fully reflect a firm’s actual sustainability capabilities.

5 CONCLUSION

This study takes China's 2015-2019 CSI 300 index constituent firms as the research data and self-constructs the ESG voluntary disclosure index to measure firms' ESG information disclosure level based on China-specific requirements. This study examines the impact of analyst attention on firms' ESG scores and the mediating role of voluntary ESG information disclosure on ESG scores. We found that increased analyst attention leads to significantly higher ESG scores and promotes greater voluntary ESG disclosure. Furthermore, our mediation analysis confirmed that voluntary ESG disclosure partially mediates the effect of analyst attention on ESG scores, accounting for approximately 35% of the total positive impact. The study also revealed a crucial moderating role for media coverage: the positive relationship between analyst attention, ESG disclosure, and ESG scores is most pronounced for firms with substantial media coverage. These findings suggest that ESG scores are significantly influenced by the quantity and accessibility of disclosed ESG information which is mediated by the

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attention of analysts, and further conditioned by the broader information environment including media. This research offers valuable insights for policymakers, ESG rating agencies, firms, and investors regarding the drivers and interpretations of ESG performance in an evolving regulatory landscape. ESG scores are not merely a measure of corporate responsibility. They offer a holistic framework for understanding and enhancing corporate competitiveness and securing sustainable long-term advantage through attracting capital and investors, better operational efficiencies and cost savings, enhanced brand reputation and customer loyalty, and risk mitigation and regulatory resilience. Investigation of various factors affecting ESG scores is important for many stakeholders.

This study has the following shortcomings. First, the research data in this study are all from the sample of constituent companies of the CSI 300 index. Although they include most listed firms with large scale and good liquidity, the sample size only accounts for a small proportion of the listed firms in China. Considering that the level of voluntary disclosure is related to the size of the firms, this study does not include small firms, which are unlikely to prepare ESG or sustainability reports. Therefore, this study may have a sample selectivity bias, leading to the research conclusions' non-generalizability. Secondly, the process of constructing the voluntary disclosure index is somewhat subjective, and there are limitations in the number of indicators selected and the way they are measured, which leads to distortion of the analysis results. At the same time, only the quantity of information disclosure is measured, and the quality of ESG information and the value it contains in itself are not adequately studied. Future similar research can address these shortcomings.

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