How does corporate ESG performance affect stock liquidity? Evidence from China

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ABSTRACT

This study examines whether and how corporate environmental, social, and governance (ESG) performance is associated with firm's stock liquidity. We find robust evidence that ESG performance statistically and significantly increases firm's stock liquidity. The results of channel tests indicate that ESG performance increases firm's stock liquidity by lowering corporate risk and gaining stakeholders' support. Additionally, we find that the positive effect of corporate ESG performance is driven by all the three dimensions. Collectively, our study highlights the importance of corporate ESG performance and its economic consequences.

1. Introduction

In the past few decades, sustainable development has received a lot of attention. To achieve the Sustainable Development Goals (2015–2030) set by the United Nations in 2015, countries around the world are calling for actions, committing to mobilize financial resources, and strengthening institutional capacity. Environmental protection, social inclusion and economic growth are viewed as the key drivers in promoting high-quality socioeconomic development. ESG has been actively practiced in developed countries such as Europe and the United States, and it has become an important concept for sustainable governance all over the world. Under the trend of global economic integration, ESG can be a passport for "going global" and improving the performance of enterprises in the capital market. Therefore, there has been a sharp increase in interest by policymakers, firms, investors and academic researchers to investigate the relationship between ESG and capital markets.

ESG concept, which was proposed by the United Nations Global Compact in 2004, is one of the practical frameworks for promoting sustainable development (Rajesh and Rajendran, 2020). Employing the concept of ESG and its related practices in social-level, firm-level or market-level has become a new international trend (Umar et al., 2020). Formally, ESG is a non-financial evaluation system with three dimensions including environmental (E), social (S), and governance (G). It is a systematic methodology to promote socioeconomic and corporate sustainability, put emphasis on the maximization of social welfare while pursuing the economic benefits of firms. In this study, we focus on firm-level ESG performance (i.e., corporate ESG performance) and its economic consequences.

Corporate ESG is an extension of corporate social responsibility (CSR). While both ESG and CSR are measured in same dimensions in the business, CSR emphasizes corporate social responsibility (S), ESG pays more attention to business activities and firm's strategic development. Prior studies highlight the important role of ESG performance in different corporate outcomes, as well as its economic consequences.[1] While studies suggest the impact of ESG on the returns of industry portfolios (Díaz et al., 2021), implied volatility (Patel et al., 2021), market value (Tampakoudis and Anagnostopoulou, 2020; Mervelskemper and Streit, 2017), stock market returns (Weber, 2014), idiosyncratic volatility (Ng and Rezaee, 2020), and stock price synchronicity (Schiehll and Kolahgar, 2021), our current understanding of the effect of corporate ESG performance on stock liquidity is still limited. On the one hand, due to the booming development of ESG in China in recent years, whether ESG can really gain the recognition and support of investors and play an active role in guiding capital flow to achieve the win-win situation of corporate business value and social value is an issue to be explored. On the other hand, how ESG can play a role in stock liquidity is an important key point that needs to be urgently analyzed, which is important to further promote the process of ESG in China and improve the sustainable development of listed companies. Therefore, filling in this gap in the literature is the main motivation for our research.

Stock liquidity is a key indicator of capital market development (Stiglitz, 1981; Atawnah et al., 2018; Huang et al., 2020). Drawn on the literature, prior studies related to the determinants of stock liquidity have two perspectives: First, from a corporate perspective, prior studies discuss the information transparency and examine the effect of mandatory disclosure of mutual funds (e.g., Agarwal et al., 2015), trader anonymity (e.g., Meling, 2021), and the strength of the lending relationship between firms and banks (Dass and Massa, 2011) on stock liquidity. Second, from a macro perspective, prior studies suggest that factors such as stock market downturns (e.g., Hameed et al., 2010), uncertainty (e.g., Chung and Chuwonganant, 2014), and poor national governance (e.g., Lin et al., 2014) could have a negative effect on stock liquidity. Collectively, studies in this line of literature focus on firm's behavior and the relationship between firm and its stakeholders on stock liquidity.

ESG behavior is a way for a firm to obtain the support from both internal and external resources to meet the needs of stakeholders,[2] in order to ultimately increase economic returns (Chen and Yang, 2020). However, ex ante, it is unclear whether and how corporate ESG performance influences firm's stock liquidity. For example, ESG could exert an "insurance effect" to help a firm to reduce risk in its business (Koh et al., 2014; Mithani, 2017; Zhou and Wang, 2020), which enhances investors' confidence in the firm and thereby increase stock liquidity. Additionally, a higher ESG score (rating) indicates better ESG performance, which represents the extent to which a firm contributes to the sustainable development regarding environmental and social investments, reflecting a responsible corporate image (Weber, 2014; Grewal et al., 2019). Kim et al. (2018) show that a good corporate image could help a firm to gain more support and trust from stakeholders. At the same time, trust and support from stakeholders could help improve corporate stock liquidity (Gurun et al., 2018; Lee and Ryu, 2019). Therefore, ESG performance has a positive effect on stock liquidity. In contrast, corporate ESG behavior might create agency problems (e.g., Xie et al., 2019; Di Giuli and Kostovetsky, 2014). Some studies have shown that the higher the agency cost of enterprises, the lower the liquidity of stocks (Ajina and Habib, 2017; Atawnah et al., 2018). Therefore, ESG performance has a negative effect on stock liquidity.

As discussed above, there is a disagreement on the role of corporate ESG performance in stock liquidity between prior studies. Therefore, we test these competing hypotheses in our study. Specifically, using a final sample of 19,308 firm-year observations (3322 listed firms) in China from 2010 to 2020, we investigate whether and how corporate ESG performance influences firm's stock liquidity. We find that firm with a higher ESG score tends to have a greater level of stock liquidity. This finding suggests that corporate ESG performance play a positive role in stock liquidity. Our results are robust with respect to alternative ESG measures and model specifications. Additional analysis shows that the positive effect of ESG performance in stock liquidity is more pronounced for state-owned enterprises (SOEs) and for those firms in heavily polluting industry. Moreover, in the channel tests, we find that ESG performance increases stock liquidity by lowering corporate risk and gaining stakeholders' supports. Finally, we find that the positive effect of corporate ESG performance is driven by all the three dimensions.

Our study contributes to the existing literature in the following aspects: firstly, corporate ESG practice is viewed as an extension of CSR, where corporate ESG practice takes corporate governance into consideration, with a focal point on business activities and firm's strategic development. Despite the role of CSR practice in capital market has been intensively established in the literature,[3] our understanding on corporate ESG practice and its economic consequences is limited.

Secondly, through exploring the channels between ESG performance and stock liquidity, we open the "black box" of the role of corporate ESG performance in stock liquidity from a theoretical perspective. In the channel tests, we find that corporate ESG performance increases stock liquidity by reducing corporate risk and gaining stakeholders' support, which is consistent with the perspective of stakeholder theory. Thus, the findings of this paper enrich the existing literature regarding stakeholder theory by adding empirical evidence and practical implication on the effectiveness of corporate ESG practice.

Lastly, prior studies predominantly focused on the determinants of stock liquidity from the perspectives of macro level (e.g., Agarwal et al., 2015; Lin et al., 2014), market level (e.g., Hameed et al., 2010; Chung and Chuwonganant, 2014), corporate governance

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[1] For example, Tampakoudis and Anagnostopoulou, 2020; Grewal et al., 2019; Baker et al., 2021; Kim and Lee, 2020; Tsai and Wu, 2022; Havlinova and Kukacka, 2021; Behl et al., 2022; Tamayo-Torres et al., 2019.

[2] Stakeholders in this paper includes investors, consumers, employees, competitors, financial analysts, potential investors and all the other market participants.

[3] For example, Dowell et al., 2000; Luo and Bhattacharya, 2006; Cespa and Cestone, 2007; Galema et al., 2008; Prior et al., 2008; Bénabou and Tirole, 2010; Barnea and Rubin, 2010; Dhaliwal et al., 2011; Goss and Roberts, 2011; Edmans, 2011; El Ghoul et al. 2011; Servaes and Tamayo, 2013; Cheng et al., 2014; Ng and Rezaee, 2015; Dimson et al., 2015; Ioannou and Serafeim, 2015; Krüger, 2015.

and executive characteristics (Egginton and McCumber, 2019). We study the determinants of stock liquidity from the perspective of corporate behavior. Specifically, on the one hand, our study contributes to the literature related to the antecedents of stock liquidity by suggesting the positive role of corporate ESG performance in stock liquidity. On the other hand, we find that the driving effect of ESG on stock liquidity may be driven by external institutional pressures. China's stock market is policy-oriented and the market's operation is influenced by policies. Currently, ESG as a behavioral framework aligned with strategies such as sustainable development, the ESG performance of firms will be reflected in the stock market, and at the same time the stock market reflection will also force firms to improve their ESG performance (DasGupta, 2022; Sandberg et al., 2022). Therefore, this study closely fits the Chinese institutional context and provides empirical evidence to further verify the positive impact of ESG on improving the economic consequences of firms by constructing a logical framework between ESG and stock liquidity (Wang et al., 2022). In conclusion, our study contributes to further understanding of the positive role of ESG in capital markets based on the Chinese context.

The remainder of this paper is structured as follows. Section 2 discusses the related literature and develops the research hypotheses. Section 3 describes the research methodology, data and sample statistics. Section 4 presents the empirical results and provides additional analyses. Section 5 concludes the study.

2. Literature review and hypotheses development

2.1. The impact of corporate ESG performance on economic consequences

The existing studies empirically investigate the economic consequences of corporate ESG performance from different aspects. Most studies in this line of literature suggest a positive role of corporate ESG performance in corporate outcomes and capital market. For example, Grewal et al. (2019) argue that better corporate ESG performance and greater ESG disclosure led to higher abnormal returns. Tampakoudis and Anagnostopoulou (2020) find that corporate ESG performance positively influences the post-merger market value of the acquirer after the acquisition. Kim and Lee (2020) show that sustainable activities related to corporate ESG practice have a positive impact on firm performance. Baker et al. (2021) find that corporate ESG performance is negatively associated to IPO underpricing, and the result is held when corporate ESG rating is replaced by environmental (E) rating, social (S) rating, or governance (G) rating. Ng and Rezaee (2020) study the association between corporate ESG performance and idiosyncratic volatility. They show that the positive effect of corporate ESG performance on idiosyncratic volatility is stronger for the firm with more ESG disclosure or with poor firm performance. Havlinova and Kukacka (2021) find that corporate ESG performance has a positive effect on stock price after the financial crisis.

In terms of corporate ESG dimensions, prior studies highlight the importance of each ESG dimension in corporate outcomes (e.g., Mackey et al., 2007; Nollet et al., 2016). For example, Mackey et al. (2007) and Jayachandran et al. (2013) suggest a positive role of corporate ESG behavior in firm value and firm performance in both environmental (E) and social (S) dimensions. Tsai and Wu (2022) find that the firm with a better ESG performance tends to perform better in the financial crisis period. Additionally, they show that the firm with more commitments to social responsibility (S) is more likely to perform better in non-financial crisis periods. With a focus on the social (S) dimension, Godfrey (2005) find that firm's philanthropic activities lead to more intangible capital, which in turn increase shareholder wealth. Similarly, Wang and Qian (2011) argue that firm's philanthropic activities (S) have a positive effect on its financial performance. And, such positive effect is stronger for those firms with high visibility and good performance. Additionally, they conclude that philanthropic activities bring political resources to private enterprises with lack political affiliation, which in turn positively influence firm performance.

In contrast, some studies in this line of literature document a negative effect of corporate ESG performance on corporate outcomes. For example, Manchiraju and Rajgopal (2017) and Chen et al. (2018) argue that corporate ESG practice hinders shareholder value, because corporate ESG performance is at the expense of shareholders. Duque-Grisales and Aguilera-Caracuel (2021) find empirical evidence on the negative association between corporate ESG performance and firm's financial performance (FP). Such negative association is varied with geographic international diversification (i.e., internationalization of enterprises) and corporate financial slack.

Furthermore, beyond a simple linear relation, a curvilinear or a U-shaped correlation between ESG performance and firm performance is found by prior studies (e.g., Barnett and Salomon, 2006; Barnett and Salomon, 2012; Zhao and Murrell, 2016; Mervelskemper and Streit, 2017). For example, Behl et al. (2022) argue that corporate ESG performance hinders firm value in the short term, but it increases firm value in long run. Additionally, scholars find that economic consequences of ESG performance are influenced by internal factors, such as corporate innovation, human capital, and reputation (Surroca et al., 2010; Hull and Rothenberg, 2008). While prior studies provide possible explanations on the inconsistence of the direction of the association between ESG performance and corporate outcomes, our knowledge on corporate ESG performance and its economic consequences is very limited.

2.2. The determinants of stock liquidity

Researchers in accounting and finance have extensively studied the determinants of stock liquidity. At the macro level, Agarwal et al. (2015) find that mandatory portfolio disclosure of mutual funds has a positive effect on stock liquidity. Hameed et al. (2010) provide evidence on the negative impact of stock market decline on stock liquidity. Chung and Chuwonganant (2014) find negative association between stock liquidity and market uncertainty, and such negative association is conditional on the market structure. Additionally, Lin et al. (2014) point out the negative impact of information asymmetry on stock liquidity. At the micro level, Meling (2021) shows that trader anonymity has a positive impact on stock liquidity and trading volume. Therefore, increasing transparency in the stock market would discourage the participation of informed investors and the provision of liquidity to the market, which in turn

deteriorates capital market. Dass and Massa (2011) show that the higher the degree to which commercial banks have access to corporate inside information, the more it reduces stock liquidity and increases information asymmetry, which is detrimental to the capital market. In addition, the drivers of stock liquidity are also studied from a corporate governance perspective (Mbanyele and Wang, 2022; Nguyen and Muniandy, 2021). Collectively, studies related to the determinants of stock liquidity focus on firm's behavior and the relationship between firm and its stakeholders (e.g., Egginton and McCumber, 2019), it is unclear on whether and how corporate ESG performance influences stock liquidity.

2.3. The relationship between corporate ESG performance and stock liquidity

Corporate ESG performance, as a systematic methodology, put emphasis on the maximization of social welfare while pursuing the economic benefits of firms. Stock liquidity is an important indicator of the quality of capital market, which reflects the management vitality and sustainable development ability of enterprises. Prior studies find that corporate ESG performance is associated with lower capital cost, higher valuations, higher profitability (Giese et al., 2019), and lower price crash risk (Feng et al., 2021). Thus, corporate ESG performance help to create value for firms, and this value is reflected in the stock market (Ramchander et al., 2012). It is plausible that the economics consequence brought by corporate ESG performance to the firm is reflected in stock liquidity.

According to stakeholder theory (Freeman and Evan, 1990), firm considers the needs and interests of its stakeholders, because the survival and development of a firm are based on the acceptance and recognition of its business activities by internal and external stakeholders (Kostova et al., 2008). Corporate ESG performance, as a non-financial valuation system, reflects a firm's sustainability-oriented and social responsibility-oriented strategy, accumulating reputation capital to help the firm tide over difficulties (Flammer and Luo, 2015; Balakrishnan et al., 2011; Farooq et al., 2017; Wang and Qian, 2011). Supporting this point of view, prior studies find that the "insurance effect" exerted by ESG might reduce the risk faced by the firm (Patel et al., 2021), and that the stakeholders are more willing to invest in those firms with good ESG performance during financial crisis period (Lins et al., 2017). Thus, we predict that corporate ESG performance is helpful to reduce firm risk, and thereby improves stock liquidity.

Furthermore, better corporate ESG performance might help a firm to gain more support from stakeholders. Under corporate ESG performance evaluation system, both economic and social benefits are put into consideration. Generally, a firm with better ESG performance is more likely to gain stakeholders' support and trust to reduce the friction with them (Ramchander et al., 2012; Jaya-chandran et al., 2013). Thus, better ESG performance might help a firm to gain favor from investors and other stakeholders, and thereby improve firm's stock liquidity (Gurun et al., 2018; Lee and Ryu, 2019). We again predict that corporate ESG performance has a positive effect on stock liquidity.

There is an alternation prediction leading to a negative relationship between corporate ESG performance and stock liquidity. According to agency theory, using non-financial metrics as an evaluation criterion might lead a CEO to enhance his/her own interest at the expense of shareholders (Xie et al., 2019). In this case, investing in corporate ESG performance harms shareholders' interests due to agency problems (Di Giuli and Kostovetsky, 2014), which is detrimental to stock liquidity (Ajina and Habib, 2017; Atawnah et al., 2018). Thus, to the extent that a firm commits to ESG investment and perform well in ESG related activities, the investors might be less likely to invest in the firm to protect their own interests, resulting in a lower stock liquidity.

Based on the discussion above, we formulate competing hypothesis as follows:

H1a: *Corporate ESG performance has a positive effect on firm's stock liquidity.*

H1b: *Corporate ESG performance has a negative effect on firm's stock liquidity.*

3. Methodology

3.1. Model

To test our hypotheses, we estimate the following regression model. At the same time, we treat the ESG and all control variables with a one-period lag:

$$
\begin{aligned}
Liquidity_{i,t} = {} & \varphi_0 + \varphi_1 ESG_{i,t-1} + \varphi_2 Age_{i,t-1} + \varphi_3 Size_{i,t-1} + \varphi_4 SD_{i,t-1} + \varphi_5 Cash_{i,t-1} + \\
& \varphi_6 ROE_{i,t-1} + \varphi_7 BM_{i,t-1} + \varphi_8 Dual_{i,t-1} + \varphi_9 Audit_{i,t-1} + \varphi_{10} Stdret_{i,t-1} + \\
& \varphi_{11} Soe_{i,t-1} + \varphi_{12} heavilypollution_{i,t-1} + \sum Year + \sum Ind + \varepsilon
\end{aligned}
\tag{1}
$$

where ε is the random error term. The dependent variable, *Liquidity,* denotes stock liquidity. To construct *Liquidity*, we follow

Amihud (2002).[4] Specifically, we calculate stock illiquidity index (*Illiquidity*) by eq. (2) as follows:

$$Illiquidity_{i,t} = \frac{1}{Days_{i,t}} \sum_{d=1}^{Days_{i,t}} \frac{|R_{i,t,d}|}{Volume_{i,t,d}} \qquad (2)$$

In eq. (2), $|R_{i,t,d}|$ represents the absolute value of the return rate of stock i on the dth trading day of year t, $Volume_{i,t,d}$ indicates the trading amount of stock i on the dth trading day of year t, $Days_{i,t}$ is the number of trading days of stock i in year t. Thus, intuitively, $|R_{i,t,d}|/Volume_{i,t,d}$ is the change in return per unit turnover of stock i on the dth trading day in year t. The larger the stock illiquidity index, the greater the impact of the unit transaction amount on the stock price, the higher the transaction cost for investors, and the lower the stock liquidity, and vice versa. To avoid the high skewness and kurtosis of the raw stock illiquidity index, we then calculate stock liquidity index (*Liquidity*) by eq. (3) as follows (Roosenboom et al., 2014):

$$Liquidity = -\ln(Illiquidity) \qquad (3)$$

The main variable of interest is *ESG*, which measures corporate ESG performance, including environmental, social and governance dimensions.[5] We include an array of control variables documented in the literature as potential determinants of stock liquidity, such as, corporate age (*Age*), company size (*Size*), degree of stock concentration (*SD*), cash flow intensity (*Cash*), return on equity (*ROE*), book-to-market ratio (*BM*), the dual role of the board chairman (*Dual*), audit opinion (*Audit*), return volatility (*Stdret*), property nature (*Soe*), industry nature (*heavilypollution*) (Agarwal et al., 2015; Chung and Chuwonganant, 2014; Odders-White and Ready, 2006; Chen et al., 2022; Zhou et al., 2021). The detailed definition of each variable is listed in Appendix A. At last, to control for the unobserved factors that might drive the results, we add both year- and industry- fixed effects to the model.

3.2. Data and sample

We download the SSI (Sino-Securities Index) ESG rating data for corporate ESG performance from the Wind database. SSI ESG rating database collects raw data of corporate ESG performance from the disclosures of listed firms in China via various resources. Specifically, beyond the public reports on the company's website,[6] SSI ESG rating database uses machine learning and text mining methods to obtain data from government and media websites. In terms of corporate ESG performance, SSI ESG rating system consists of three primary indexes (environmental, social, and corporate governance), 14 secondary indexes, 26 tertiary indexes, and over 130 underlying data indexes. Using an industry weight matrix that is constructed based on index score and industry characteristics of listed firms, a rating of nine is finally calculated from lowest to highest, respectively. SSI ESG rating database started to publish its indexes in year 2010, therefore, the final sample period of our study is from 2010 to 2020. The data for all the other variables are downloaded from China Stock Market & Accounting Research Database (CSMAR). After merging all the data by firm-year, we first exclude all the firms in finance industry. We then exclude all firms with ST, *ST, or delisting during the sample period. Finally, we exclude firm-year observations with missing data for the control variables. Our final sample consists of 19,308 firm-year observations associated with 3322 listed firms in China over the period of 2010 to 2020.

3.3. Summary statistics

Table 1 provides the descriptive statistics of the key variables in the main analyses. To reduce the influence of outliners, all the continuous variables are winsorized at the top and bottom one percentile. The rating of corporate ESG performance from low to high is 1–9, with mean 6.622 and standard deviation 1.084. It suggests that the overall corporate ESG performance is better than the average level, however, ESG performance varies significantly between firms. The average stock liquidity is about 3.476, with a max value 6.156, the minimum value −0.846, and the standard deviation 1.131, indicating significant difference in the level of stock liquidity. In terms of the control variable, we find that the maximum value of corporate ownership concentration is 75.170, the minimum value 8.950, and the standard deviation 15.130, suggesting a significant gap in the degree of internal control of firms in our sample.

3.4. Bivariate analysis

In this subsection, we conduct a bivariate analysis using the Pearson Correlation matrix. Table 2 reports the results. Our variable of interest, *ESG*, is positively and significantly correlated with *Liquidity*. This provides preliminary evidence to support Hypothesis 1a that

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[4] Draw on the prior studies in this line of literature, two other measures of stock liquidity, turnover rate and the bid-ask spread, are used widely in US setting. Both of these two measures are based on high-frequency trading data. There are two reasons that we don't adopt these two measures: first, these two measures are used to measure the difficulty of stock transaction in the short term. Corporate ESG performance examined in our paper is a medium- to long-term behavior. Thus, the impact of corporate ESG performance on corporate stock liquidity cannot be objectively captured using high-frequency data. Second, relative to the U.S. market, China's stock market is more volatile. Additionally, there is difference between China and the U.S. in the price limits system. The illiquidity index is more intuitive in the China's capital market might more directly reflect the active level of stock trading within a certain time range.

[5] We assign a score of 1 to 9 based on the SSI ESG rating criteria (from C to AAA), respectively.

[6] Related non-financial disclosures include corporate social responsibility report, corporate sustainability development report, etc.

Table 1
Descriptive statistics.

Variables	Obs	Mean	Std. Dev.	Min	Max
ESG	19,308	6.622	1.084	1.000	9.000
Liquidity	19,308	3.476	1.131	−0.846	6.156
Age	19,308	2.804	0.366	1.609	3.466
Size	19,308	22.380	1.324	20.110	26.410
SD	19,308	35.610	15.130	8.950	75.170
Cash	19,308	0.172	0.133	0.014	0.652
ROE	19,308	0.082	0.089	−0.356	0.312
BM	19,308	0.338	0.154	0.069	0.769
Dual	19,308	0.273	0.446	0.000	1.000
Audit	19,308	0.012	0.111	0.000	1.000
Stdret	19,308	0.443	0.215	0.149	1.395
Soe	19,308	0.367	0.482	0.000	1.000
heavilypollution	19.308	0.321	0.467	0.000	1.000
Risk	19,308	−0.394	0.707	−2.552	1.570
Analyst	19,308	1.810	1.105	0.000	3.829

This table reports summary statistics for ESG performance, stock liquidity, stock price crash risk, analysts' attention, and all control variables. *ESG* use the SSI (Sino-Securities Index) ESG rating data from Wind database. *ESG* is assigned a score of 1 to 9 based on the rating criteria (from C to AAA). *Liquidity* is the opposite number of the illiquidity logarithm. *Age* is logarithm of the establishment period of listed company plus 1. *Size* is logarithm of the total assets of the company at the end of the year. *SD* is concentration degree of the largest shareholder. *Cash* is the ratio of cash and its cash equivalents to total assets. *ROE* is return on equity. *BM* is the ratio of the owner's equity to market value. *Dual* is the dual role of the board chairman. *Audit* is audit opinions. *Stdret* is deviation of corporate monthly return rate. *Soe* is property nature, that is state-owned enterprises are assigned a value of 1, otherwise 0. *heavilypollution* is industry nature, that is the heavy pollution industry is assigned a value of 1, otherwise 0. According to the *Guidelines for Classification of Listed Companies (Amended in 2012)*, including B06, B07, B08, B09, B10, C15, C17, C18, C19, C22, C25, C26, C27, C28, C29, C30, C31, C32, D44 are listed as heavily polluting industries. *Risk* is the negative return skewness coefficient for weekly stock-specific returns. *Analyst* is logarithm of the number of analysts covering the stock. The sample consists of 19,308 firm-year observations in China for the period between 2010 and 2020.

corporate ESG performance has a positive impact on firm's stock liquidity.

4. Empirical results

4.1. The effect of the ESG performance on stock liquidity

4.1.1. Baseline results

We treat the ESG and all control variables with a one-period lag. Table 3 provides the regression results for the competing hypotheses regarding the effect of corporate ESG performance on firm's stock liquidity. Column (1) shows that the coefficient on L1.*ESG* is positive and statistically significant (coefficient = 0.226, *p* value <0.01). Column (2) shows the results remain unchanged (coefficient = 0.042, p value <0.01) when control variables are added to the model. Collectively, the results in Table 3 support Hypothesis 1a that corporate ESG performance has a positive impact on firm's stock liquidity.

4.1.2. Robustness tests

We perform several tests to ensure the robustness of our findings. First, we use alternative ESG measures for corporate ESG performance. The first alternative ESG measure (L1.*Windscore*) is the total score of ESG that provided by Wind database. To construct the second alternative ESG measure (L1.*Windrating*), we first download ESG rating from Wind database. Then, we assign a score of 1 to 7 based on the rating criteria (from CCC to AAA) respectively. Since Wind database started to provide ESG data in year 2018, the sample period for this alternative sample (Wind-subsample) is from 2018 to 2020. Secondly, we construct the third alternative ESG measure (L1.*ESG_rating*) and download ESG rating from SynTao Green Finance database. Then, we assign a score of 1 to 10 based on the rating criteria (from D to A+) respectively. Since SynTao Green Finance database started to provide ESG data in year 2015, the sample period for this alternative sample is from 2015 to 2020. Additionally, we construct the fourth alternative ESG measure (L1.*ESG2*) by using different assigning method on SSI ESG rating Index. Specially, we assign a score of 1, 2, and 3 to C-CCC, B-BBB, and A-AAA respectively. The results of using alternative ESG measures in Model (1) are reported in column (1) to (4) of Table 4. As shown, the coefficient of L1.*Windscore* stands at 0.094 and that of L1.*Windrating* registers 0.082, both significant at 1%. Then, the coefficient of L1.*ESG_rating* stands at 0.038 with p value<0.1. Additionally, the coefficient of L1.*ESG2* is 0.055 with p value <0.01. Therefore, using alternative measures for corporate ESG performance, our results still hold.

Second, to alleviate the endogeneity concern that the current results are driven by unobserved factors, we add province-fixed effects to Model (1). As shown in column (5) of Table 4, the coefficient of L1.*ESG* is 0.042, which is significant at 1%, indicating the robustness of the baseline results in subsection 4.1.1.

Third, the COVID-19 pandemic that spreads around the world in 2020 brought a shock to the global economy, which influence corporate ESG behavior and firm's stock liquidity. To alleviate the concern on potential endogenous problem, we exclude all observations in 2020 from the sample. The results are reported in column (6) of Table 4, we continue to find our inference unchanged.

Table 2
Pearson correlation.

Variables	Liquidity	ESG	Age	Size	SD	Cash	ROE	BM	Dual	Audit	Stdret	Soe	heavilypollution	Risk	Analyst
Liquidity	1														
ESG	0.23***	1													
Age	0.21***	0.13***	1												
Size	0.58***	0.36***	0.25***	1											
SD	−0.05***	0.09***	−0.09***	0.20***	1										
Cash	−0.13***	−0.02**	−0.21***	−0.31***	0.01	1									
ROE	0.12***	0.10***	0.00	0.06***	0.11***	0.14***	1								
BM	−0.25***	−0.03***	−0.10***	−0.05***	0.05***	0.16***	−0.09***	1							
Dual	−0.11***	−0.11***	−0.11***	−0.20***	−0.06***	0.10***	0.01*	0.02**	1						
Audit	0.00	−0.05***	0.03***	−0.00	−0.03***	−0.04***	−0.17***	−0.04***	−0.01	1					
Stdret	−0.17***	−0.13***	−0.07***	−0.24***	−0.07***	0.06***	−0.05***	−0.27***	0.08***	0.01**	1				
Soe	0.20***	0.27***	0.18***	0.39***	0.24***	−0.12***	−0.05***	−0.07***	−0.31***	−0.01*	−0.15***	1			
heavilypollution	0.04***	−0.03***	0.02***	0.05***	0.06***	−0.12***	0.01*	0.07***	−0.05***	0.01	−0.07***	0.07***	1		
Risk	0.04***	−0.02**	−0.02**	−0.01	−0.02***	0.03***	0.06***	0.02**	0.03***	0.02***	−0.13***	−0.06***	0.01	1	
Analyst	0.35***	0.17***	−0.11***	0.28***	0.03***	0.09***	0.37***	−0.11***	0.02**	−0.06***	−0.06***	−0.03***	0.01	0.14***	1

All variables in this table are not lagged. This table presents the correlations among stock liquidity, ESG performance, and other variables. This table reports summary statistics for ESG performance, stock liquidity, stock price crash risk, analysts' attention, and all control variables. *ESG* use the SSI (Sino-Securities Index) ESG rating data from Wind database. *ESG* is assigned a score of 1 to 9 based on the rating criteria (from C to AAA). *Liquidity* is the opposite number of the illiquidity logarithm. *Age* is logarithm of the establishment period of listed company plus 1. *Size* is logarithm of the total assets of the company at the end of the year. *SD* is concentration degree of the largest shareholder. *Cash* is the ratio of cash and its cash equivalents to total assets. *ROE* is return on equity. *BM* is the ratio of the owner's equity to market value. *Dual* is the dual role of the board chairman. *Audit* is audit opinions. *Stdret* is deviation of corporate monthly return rate. *Soe* is property nature, that is state-owned enterprises are assigned a value of 1, otherwise 0. *heavilypollution* is industry nature, that is the heavy pollution industry is assigned a value of 1, otherwise 0. According to the *Guidelines for Classification of Listed Companies (Amended in 2012)*, including B06, B07, B08, B09, B10, C15, C17, C18, C19, C22, C25, C26, C27, C28, C29, C30, C31, C32, D44 are listed as heavily polluting industries. *Risk* is the negative return skewness coefficient for weekly stock-specific returns. *Analyst* is logarithm of the number of analysts covering the stock. The sample consists of 19,308 firm-year observations in China for the period between 2010 and 2020. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.

Table 3
The impact of ESG on stock liquidity.

Variables	(1)	(2)
	Liquidity	
L1.*ESG*	0.226***	0.042***
	(30.239)	(7.616)
L1.*Age*		−0.073***
		(−4.569)
L1.*Size*		0.483***
		(89.835)
L1.*SD*		−0.010***
		(−26.478)
L1.*Cash*		0.580***
		(13.517)
L1.*ROE*		2.015***
		(25.846)
L1.*BM*		−1.309***
		(−31.248)
L1.*Dual*		0.030**
		(2.546)
L1.*Audit*		0.082
		(1.239)
L1.*Stdret*		0.579***
		(16.521)
L1.*Soe*		0.044***
		(3.284)
L1.*heavilypollution*		0.017
		(1.394)
Constant	1.895***	−7.083***
	(23.139)	(−54.236)
Observations	14,312	14,312
Industry FE	Yes	Yes
Year FE	Yes	Yes
R-squared	0.288	0.626

This table reports results from regressions of the stock liquidity on ESG performance. *ESG* use the SSI (Sino-Securities Index) ESG rating data from Wind database. *ESG* is assigned a score of 1 to 9 based on the rating criteria (from C to AAA). *Liquidity* is the opposite number of the illiquidity logarithm. *Age* is logarithm of the establishment period of listed company plus 1. *Size* is logarithm of the total assets of the company at the end of the year. *SD* is concentration degree of the largest shareholder. *Cash* is the ratio of cash and its cash equivalents to total assets. *ROE* is return on equity. *BM* is the ratio of the owner's equity to market value. *Dual* is the dual role of the board chairman. *Audit* is audit opinions. *Stdret* is deviation of corporate monthly return rate. *Soe* is property nature, that is state-owned enterprises are assigned a value of 1, otherwise 0. *heavilypollution* is industry nature, that is the heavy pollution industry is assigned a value of 1, otherwise 0. According to the *Guidelines for Classification of Listed Companies (Amended in 2012)*, including B06, B07, B08, B09, B10, C15, C17, C18, C19, C22, C25, C26, C27, C28, C29, C30, C31, C32, D44 are listed as heavily polluting industries. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively. t-value in bracket.

Fourth, to further alleviate the endogeneity concern, we introduce instrumental variable into our model. Specifically, following Breuer et al. (2018) and EI Ghoul et al. (2011), we use industry-year mean of *ESG* (*IV_indYmean*) and regional-year mean of *ESG* (*IV_cityYmean*) as the instrumental variables for regression respectively. These two instrument variables may be exogenous to ESG performance because a firm's ESG-related activities can be influenced by other firms in neighboring regions or in the same industry (Attig et al., 2013). Column (1) of Table 5 shows the results for first stage regression, in which two IV regression coefficients are significantly positive at 1% level, indicating the two instrumental variables used in this regression are highly correlated with corporate ESG performance. Column (2) shows the results for the second stage regression, the coefficient of L1.*ESG* is 0.037, which is significant at 1% level, suggesting a significantly positive effect of corporate ESG performance on stock liquidity as we predict in Hypothesis 1a.

4.2. Channel tests

In this subsection, we examine the channels through which corporate ESG performance influences firm's stock liquidity.

Table 4
Robustness test.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
				Liquidity		
L1.**Windscore**	0.094***					
	(8.015)					
L1.**Windrating**		0.082***				
		(7.931)				
L1.**ESG_rating**			0.038*			
			(1.944)			
L1.**ESG2**				0.055***		
				(4.815)		
L1.**ESG**					0.042***	
					(7.514)	
L1.**ESG**						0.045***
						(7.630)
L1.Age	−0.136***	−0.137***	−0.227***	−0.072***	−0.062***	−0.058***
	(−4.605)	(−4.610)	(−3.440)	(−4.512)	(−3.906)	(−3.535)
L1.Size	0.529***	0.528***	0.343***	0.488***	0.480***	0.479***
	(72.877)	(72.695)	(17.143)	(91.762)	(88.352)	(84.476)
L1.SD	−0.008***	−0.008***	−0.013***	−0.010***	−0.010***	−0.010***
	(−13.057)	(−13.089)	(−10.333)	(−26.584)	(−26.219)	(−25.169)
L1.Cash	0.959***	0.960***	0.874***	0.589***	0.518***	0.565***
	(12.611)	(12.634)	(4.950)	(13.732)	(11.984)	(12.710)
L1.ROE	0.842***	0.848***	2.871***	2.029***	2.066***	2.072***
	(14.558)	(14.660)	(10.421)	(25.976)	(26.493)	(25.149)
L1.BM	−1.122***	−1.120***	−1.124***	−1.307***	−1.274***	−1.189***
	(−20.463)	(−20.391)	(−6.638)	(−31.121)	(−30.413)	(−26.881)
L1.Dual	0.047***	0.047***	0.042	0.030**	0.032***	0.029**
	(2.737)	(2.724)	(0.869)	(2.549)	(2.712)	(2.324)
L1.Audit	−0.149***	−0.153***	1.007***	0.076	0.089	0.136*
	(−2.960)	(−3.044)	(10.150)	(1.149)	(1.388)	(1.874)
L1.Stdret	0.962***	0.962***	0.414***	0.572***	0.571***	0.560***
	(18.913)	(18.864)	(3.396)	(16.331)	(16.348)	(15.378)
L1.Soe	−0.090***	−0.090***	0.176***	0.051***	0.034**	0.055***
	(−4.210)	(−4.203)	(3.895)	(3.789)	(2.466)	(3.893)
L1.heavilypollution	0.003	0.002	0.076	0.016	0.018	0.021
	(0.164)	(0.127)	(1.426)	(1.258)	(1.433)	(1.577)
Constant	−7.797***	−7.500***	−2.496***	−7.059***	−6.973***	−7.086***
	(−36.292)	(−36.334)	(−4.213)	(−53.888)	(−52.073)	(−51.798)
Observations	6068	6068	1094	14,312	14,312	12,722
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	No	No	No	No	Yes	No
R-squared	0.572	0.572	0.469	0.625	0.632	0.624

This table represents robustness test results. *Windscore* and *Windrating* use the Wind database. *Windrating* is assigned a score of 1 to 7 based on the rating criteria (from CCC to AAA). *ESG_rating* use the SynTao Green Finance database. *ESG_rating* is assigned a score of 1 to 10 based on the rating criteria (from D to A+). *ESG2* use the SSI (Sino-Securities Index) ESG rating data from Wind database. *ESG2* is assigned a score of 1, 2, and 3 to C-CCC, B-BBB, and A-AAA respectively. *Liquidity* is the opposite number of the illiquidity logarithm. *Age* is logarithm of the establishment period of listed company plus 1. *Size* is logarithm of the total assets of the company at the end of the year. *SD* is concentration degree of the largest shareholder. *Cash* is the ratio of cash and its cash equivalents to total assets. *ROE* is return on equity. *BM* is the ratio of the owner's equity to market value. *Dual* is the dual role of the board chairman. *Audit* is audit opinions. *Stdret* is deviation of corporate monthly return rate. *Soe* is property nature, that is state-owned enterprises are assigned a value of 1, otherwise 0. *heavilypollution* is industry nature, that is the heavy pollution industry is assigned a value of 1, otherwise 0. According to the *Guidelines for Classification of Listed Companies (Amended in 2012)*, including B06, B07, B08, B09, B10, C15, C17, C18, C19, C22, C25, C26, C27, C28, C29, C30, C31, C32, D44 are listed as heavily polluting industries. *,** and *** denote significance at the 10%, 5% and 1% levels, respectively. t-value in bracket.

4.2.1. Risk reduction mechanism

Corporate ESG performance considers both economic and social benefits of a firm. A firm with better ESG performance is more likely to gain extra support of investors and other stakeholders, and to reduce impact of internal and external risks when firms get stuck in a plight (Koh et al., 2014; Shiu and Yang, 2017; Flammer, 2013; Godfrey, 2005; Zhou and Wang, 2020). Hence, it is plausible that corporate ESG performance, as a risk reduction mechanism, helps to reduce risk, and thereby improves firm's capital market liquidity. To examine the role of risk reduction mechanism in the association between corporate ESG performance and firm's stock liquidity, we use Model (4) as follows:

Table 5
Endogenous test: IV results on the effect of ESG on stock liquidity.

	(1)	(2)
	First stage	Second stage
Variables	L1.ESG	Liquidity
L1.**ESG**		0.037***
		(2.846)
L1.Age	0.081***	−0.072***
	(3.495)	(−4.545)
L1.Size	0.215***	0.484***
	(30.675)	(79.434)
L1.SD	−0.002***	−0.010***
	(−3.887)	(−26.477)
L1.Cash	0.195***	0.583***
	(3.356)	(13.499)
L1.ROE	0.725***	2.019***
	(6.850)	(25.753)
L1.BM	−0.023	−1.309***
	(−0.410)	(−31.297)
L1.Dual	−0.004	0.030**
	(−0.228)	(2.550)
L1.Audit	−0.188**	0.081
	(−2.179)	(1.215)
L1.Stdret	−0.367***	0.577***
	(−8.769)	(16.347)
L1.Soe	0.222***	0.046***
	(11.775)	(3.318)
L1.heavilypollution	−0.006	0.017
	(−0.323)	(1.382)
L1.IV_indYmean	0.580***	
	(9.995)	
L1.IV_cityYmean	0.845***	
	(58.920)	
Constant	−7.694***	−6.237***
	(−19.460)	(−45.469)
Observations	14,312	14,312
Industry FE	Yes	Yes
Year FE	Yes	Yes
R-squared	0.364	0.626

This table presents results of an instrumental variable regression of stock liquidity on ESG performance and the regression results of matched ESG performance on stock liquidity. *ESG* use the SSI (Sino-Securities Index) ESG rating data from Wind database. *ESG* is assigned a score of 1 to 9 based on the rating criteria (from C to AAA). *Liquidity* is the opposite number of the illiquidity logarithm. *Age* is logarithm of the establishment period of listed company plus 1. *Size* is logarithm of the total assets of the company at the end of the year. *SD* is concentration degree of the largest shareholder. *Cash* is the ratio of cash and its cash equivalents to total assets. *ROE* is return on equity. *BM* is the ratio of the owner's equity to market value. *Dual* is the dual role of the board chairman. *Audit* is audit opinions. *Stdret* is deviation of corporate monthly return rate. *Soe* is property nature, that is state-owned enterprises are assigned a value of 1, otherwise 0. *heavilypollution* is industry nature, that is the heavy pollution industry is assigned a value of 1, otherwise 0. According to the Guidelines for Classification of Listed Companies (Amended in 2012), including B06, B07, B08, B09, B10, C15, C17, C18, C19, C22, C25, C26, C27, C28, C29, C30, C31, C32, D44 are listed as heavily polluting industries. *IV_indYmean* is the industry-year mean of ESG. *IV_cityYmean* is the regional-year mean of ESG. *IV_indYmean* and *IV_cityYmean* are both instrumental variables. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively. t-value in bracket.

$$
\begin{aligned}
Liquidity_{i,t} &= \varphi_0 + \varphi_1 ESG_{i,t-1} + \varphi_2 Risk_{i,t} + \varphi_3 ESG_{i,t-1} \times Risk_{i,t} + \varphi_4 Age_{i,t-1} + \\
&\quad \varphi_5 Size_{i,t-1} + \varphi_6 SD_{i,t-1} + \varphi_7 Cash_{i,t-1} + \varphi_8 ROE_{i,t-1} + \varphi_9 BM_{i,t-1} + \\
&\quad \varphi_{10} Dual_{i,t-1} + \varphi_{11} Audit_{i,t-1} + \varphi_{12} Stdret_{i,t-1} + \varphi_{13} Soe_{i,t-1} + \\
&\quad \varphi_{14} heavilypollution_{i,t-1} + \sum Year + \sum Ind + \varepsilon
\end{aligned}
\tag{4}
$$

Following Hutton et al. (2009), Feng et al. (2021), Gao et al. (2022), Yu et al. (2023), we use stock price crash risk (*Risk*) to test risk reduction. The stock price crash risk is a direct reflection of corporate fundamentals in the capital markets. The advantage of non-financial information contained in ESG can reduce the risk of stock price crash caused by information asymmetry. And the social

reputation brought by ESG-related activities of a company can reduce the stock price crash risk (Yu et al., 2023; Feng et al., 2021; Li et al., 2017). Therefore, the better the ESG performance of a company, the lower the risk of a stock crash (Gao et al., 2022).

As shown in column (1) of Table 6, the coefficient of the interaction of stock price crash risk and L1.*ESG* stands at 0.017, passing the 5% statistical significance test, which indicates that the stock price crash risk boosts the positive impact of ESG performance on stock liquidity. That is, when a firm faces higher risk, the effect of corporate ESG performance on stock liquidity is stronger. This finding supports our conjecture on risk reduction mechanism.

4.2.2. Stakeholder support mechanism

Corporate ESG performance reflects a firm's sustainability-oriented and social responsibility-oriented strategy, which helps the firm to accumulate intangible assets such as reputation and to improve its soft power (Flammer and Luo, 2015; Balakrishnan et al., 2011; Farooq et al., 2017; Wang and Qian, 2011). Therefore, how well the information regarding corporate ESG behaviors is delivered to the investors and other stakeholders is very important. Information is crucial for individual's decision-making (Kong et al., 2019),

Table 6
Channel test: risk reduction mechanism and stakeholder support mechanism.

Variables	(1)	(2)	(3)
		Liquidity	
L1.*ESG*	0.042***	0.027***	0.028***
	(7.642)	(5.002)	(5.104)
Risk	0.070***		0.043***
	(9.093)		(5.739)
Analyst		0.177***	0.173***
		(32.996)	(31.995)
L1.*ESG*×Risk	0.017**		0.009
	(2.369)		(1.303)
L1.*ESG*×Analyst		0.024***	0.023***
		(5.498)	(5.100)
L1.*Age*	−0.069***	−0.018	−0.017
	(−4.354)	(−1.159)	(−1.094)
L1.*Size*	0.482***	0.422***	0.423***
	(90.033)	(76.345)	(76.640)
L1.*SD*	−0.010***	−0.009***	−0.009***
	(−26.412)	(−25.050)	(−25.043)
L1.*Cash*	0.569***	0.429***	0.425***
	(13.249)	(10.217)	(10.129)
L1.*ROE*	1.958***	1.224***	1.207***
	(25.274)	(15.884)	(15.725)
L1.*BM*	−1.280***	−1.129***	−1.115***
	(−30.626)	(−27.957)	(−27.621)
L1.*Dual*	0.028**	0.019	0.018
	(2.345)	(1.628)	(1.522)
L1.*Audit*	0.072	0.101*	0.095
	(1.096)	(1.688)	(1.586)
L1.*Stdret*	0.577***	0.590***	0.589***
	(16.523)	(16.853)	(16.851)
L1.*Soe*	0.050***	0.100***	0.102***
	(3.709)	(7.710)	(7.874)
L1.*heavilypollution*	0.016	0.021*	0.019
	(1.260)	(1.720)	(1.626)
Constant	−7.054***	−6.160***	−6.166***
	(−54.170)	(−47.246)	(−47.360)
Observations	14,312	14,312	14,312
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
R-squared	0.629	0.653	0.654

This table presents the channel test results. *ESG* use the SSI (Sino-Securities Index) ESG rating data from Wind database. *ESG* is assigned a score of 1 to 9 based on the rating criteria (from C to AAA). *Liquidity* is the opposite number of the illiquidity logarithm. *Age* is logarithm of the establishment period of listed company plus 1. *Size* is logarithm of the total assets of the company at the end of the year. *SD* is concentration degree of the largest shareholder. *Cash* is the ratio of cash and its cash equivalents to total assets. *ROE* is return on equity. *BM* is the ratio of the owner's equity to market value. *Dual* is the dual role of the board chairman. *Audit* is audit opinions. *Stdret* is deviation of corporate monthly return rate. *Soe* is property nature, that is state-owned enterprises are assigned a value of 1, otherwise 0. *heavilypollution* is industry nature, that is the heavy pollution industry is assigned a value of 1, otherwise 0. According to the Guidelines for Classification of Listed Companies (Amended in 2012), including B06, B07, B08, B09, B10, C15, C17, C18, C19, C22, C25, C26, C27, C28, C29, C30, C31, C32, D44 are listed as heavily polluting industries. *Risk* is the negative return skewness coefficient for weekly stock-specific returns. *Analyst* is logarithm of the number of analysts covering the stock. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively. t-value in bracket.

however, stakeholders might not always have access to obtain information about firms (Greenwald and Stiglitz, 1990). Hence, it is plausible that the more the stakeholders know about the ESG information of a firm, the more the stakeholders are willing to provide corresponding support and resources for that firm, and thereby improve firm's stock liquidity (Aouadi et al., 2018). To examine the role of stakeholder support mechanism in the association between corporate ESG performance and firm's stock liquidity, we use Model (5) as follows:

$$
\begin{aligned}
Liquidity_{i,t} &= \varphi_0 + \varphi_1 ESG_{i,t-1} + \varphi_2 Analyst_{i,t} + \varphi_3 ESG_{i,t-1} \times Analyst_{i,t} + \varphi_4 Age_{i,t-1} + \\
&\quad \varphi_5 Size_{i,t-1} + \varphi_6 SD_{i,t-1} + \varphi_7 Cash_{i,t-1} + \varphi_8 ROE_{i,t-1} + \varphi_9 BM_{i,t-1} + \\
&\quad \varphi_{10} Dual_{i,t-1} + \varphi_{11} Audit_{i,t} + \varphi_{12} Stdret_{i,t-1} + \varphi_{13} Soe_{i,t-1} + \\
&\quad \varphi_{14} heavilypollution_{i,t-1} + \sum Year + \sum Ind + \varepsilon
\end{aligned}
\tag{5}
$$

Financial analyst plays a crucial role in the process of information transmission, and his/her analysis regarding corporate information helps to reduce information asymmetry in the market (Ramchander et al., 2012; Benlemlih et al., 2018; Luo et al., 2015). Thus, following Kot and Tam (2016), we use the number of analysts following a firm to measure analysts' attention in Model (5). A greater number of analysts following a firm indicates that the more ESG related information is delivered to the investors and other stakeholders in the market.

As shown in column (2) of Table 6, the coefficient of the interaction term of analyst attention and L1.ESG stands at 0.024, passing the 1% statistical significance test, which indicates that the analyst attention strengthens the positive impact of ESG performance on

Table 7
The ESG effect on stock liquidity under different corporate ownership and industry attribution.

	(1)	(2)	(3)	(4)
	SOE	non-SOE	heavily polluting	non-heavily polluting
Variables		*Liquidity*		
L1.*ESG*	0.080***	0.024***	0.044***	0.020***
	(9.110)	(3.522)	(4.882)	(2.910)
L1.*Age*	−0.156***	−0.051***	−0.066**	−0.191***
	(−4.823)	(−2.705)	(−2.055)	(−9.575)
L1.*Size*	0.436***	0.520***	0.461***	0.441***
	(55.160)	(73.877)	(50.495)	(68.776)
L1.*SD*	−0.010***	−0.009***	−0.010***	−0.011***
	(−16.365)	(−20.580)	(−15.284)	(−24.119)
L1.*Cash*	0.720***	0.624***	0.767***	0.633***
	(8.487)	(12.384)	(9.468)	(11.917)
L1.*ROE*	2.512***	1.553***	2.689***	1.558***
	(22.619)	(17.803)	(23.076)	(16.804)
L1.*BM*	−0.620***	−1.673***	−1.288***	−1.136***
	(−8.818)	(−34.563)	(−19.021)	(−22.316)
L1.*Dual*	0.076**	0.028**	−0.013	0.058***
	(2.560)	(2.180)	(−0.595)	(3.735)
L1.*Audit*	0.097	0.038	0.017	0.191**
	(0.967)	(0.567)	(0.177)	(2.546)
L1.*Stdret*	0.883***	0.482***	0.695***	0.590***
	(14.078)	(13.216)	(11.206)	(14.894)
L1.*Soe*	0.033	−0.111	0.060**	0.041**
	(0.412)	(−1.343)	(2.575)	(2.477)
L1.*heavilypollution*	0.010	0.031**	0.105	0.010
	(0.467)	(2.131)	(1.127)	(0.110)
Constant	−6.243***	−7.785***	−7.143***	−6.205***
	(−28.053)	(−45.412)	(−30.089)	(−41.659)
Observations	5388	8924	4678	9634
Industry FE	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	Yes
R-squared	0.608	0.647	0.607	0.584
Prob>chi2	0.000		0.041	

This table presents the grouping test results. *ESG* use the SSI (Sino-Securities Index) ESG rating data from Wind database. *ESG* is assigned a score of 1 to 9 based on the rating criteria (from C to AAA). *Liquidity* is the opposite number of the illiquidity logarithm. *Age* is logarithm of the establishment period of listed company plus 1. *Size* is logarithm of the total assets of the company at the end of the year. *SD* is concentration degree of the largest shareholder. *Cash* is the ratio of cash and its cash equivalents to total assets. *ROE* is return on equity. *BM* is the ratio of the owner's equity to market value. *Dual* is the dual role of the board chairman. *Audit* is audit opinions. *Stdret* is deviation of corporate monthly return rate. *Soe* is property nature, that is state-owned enterprises are assigned a value of 1, otherwise 0. *heavilypollution* is industry nature, that is the heavy pollution industry is assigned a value of 1, otherwise 0. According to the *Guidelines for Classification of Listed Companies (Amended in 2012)*, including B06, B07, B08, B09, B10, C15, C17, C18, C19, C22, C25, C26, C27, C28, C29, C30, C31, C32, D44 are listed as heavily polluting industries. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively. t-value in bracket.

stock liquidity. That is, when analysts pay more attention to a firm, the effect of corporate ESG performance on stock liquidity is stronger. The finding supports our conjecture on stakeholder support mechanism.

4.3. Additional tests on corporate types

In this subsection, we examine whether and how the effect of corporate ESG performance on stock liquidity varies with corporate types.

4.3.1. SOEs V.S. non-SOEs

Corporate ESG performance is an important non-financial indicator to evaluate sustainable development ability of the firm. A firm usually needs to integrate resources and invest heavily in order to perform well in ESG practice. Additionally, corporate ESG investments always take a long time to pay off. To perform well in ESG practice, a firm needs strong hard power and soft power, including corporate culture and philosophy. State-owned enterprises (SOEs) are expected to gain both economic and social benefits, because SOEs are supported by fiscal policies, having a stronger drive to fulfill their social responsibilities and obligations. Furthermore, large shareholders generally pay more attention to the long-term development of firms (Edmans and Manso, 2011). As a result, SOEs with equity concentration have a long-term vision of investment, which is more conductive to the realization of ESG strategy. In contrast, while non-SOEs increase their investment in ESG in the past a few years, most of them invest in order to maximize their economic benefits only. Therefore, we examine whether the effect of corporate ESG performance in stock liquidity varies with corporate ownership in this subsection.

The results of the tests are presented in column (1) and (2) of Table 7. Specifically, we first partition our sample based on whether a firm is stated-owned. Then, we run regression Model (1) in each sub-sample. After regression, we find that the coefficients of SOEs and non-SOEs are 0.080 and 0.024 respectively, significantly different from zero at 1%, and significant differences exist between groups. These results indicate that the ESG performance of both SOEs and non-SOEs has a significantly positive impact on stock liquidity, however, such positive effect in SOEs is much stronger than it in non-SOEs. From the results, it is clear that in the Chinese context, the specific attributes of SOEs lead to better ESG performance driven by institutional pressures, and then a stronger role of ESG in improving stock liquidity (Chen et al., 2017). This finding supports our conjecture above.

4.3.2. Heavily polluting V.S. non-heavily polluting

We next examine whether the effect of corporate ESG performance in stock liquidity varies with industry attributes. Adhering to sustainable-development related concept, such as and carbon peaking and carbon neutralization,[7] stakeholders' expectation for corporate ESG performance are gradually increasing, especially on the firms in heavily polluting industry. In this context, corporate ESG performance related to environmental protection and social responsibility has become one of the criteria for stakeholders to evaluate whether a firm has potential for a long-term development. Therefore, it is interesting to know whether and industry attributes influence the effect of corporate ESG performance. To find the empirical evidence, we partition our sample based on whether a firm is in heavily polluting industry. Then, we run regression Model (1) in each sub-sample.

Results are reported in column (3) and column (4) of Table 7. The coefficient of L1.*ESG* in heavily polluting industry registers 0.044 and that of L1.*ESG* in non-heavily polluting industry is 0.020, both passing the 1% statistical significance test. Additionally, the difference between two subsamples is statistically significant. Collectively, the results indicate that the effect of corporate ESG performance on stock liquidity in both heavily polluting industry and non-heavily polluting industry is positive and statistically significant, however, such positive effect in heavily polluting industry is greater relative to it in non-heavily polluting industry. We find that, similar to above, the findings reveal the subtle role played by external institutional pressures. Firms in heavily polluting industry are subject to more institutional pressures due to their industry attributes, and thus have better ESG performance (Chen et al., 2022). Therefore, the positive effect of corporate ESG performance on stock liquidity is more pronounced in heavily polluting industry.

4.4. Discussion on ESG dimensions

Corporate ESG performance is a critical issue globally and is a primary corporate governance concern for many firms. In the last few decades, an increasing number of investors are integrating ESG dimensions (i.e., environmental, social and corporate governance) into their investment decisions based on both financial and social considerations (Dyck et al., 2019; Limkriangkrai et al., 2016). Therefore, it is interesting to know how corporate ESG performance is manifested in different dimensions and how each ESG dimension influences firm's stock liquidity.

Environmental score, social score, and governance score are available in Wind database. Because Wind database started to disclose the data for ESG pillars in 2018, the sample period for this test is from 2018 to 2020. As shown in Table 8, the results show that the positive effect of corporate ESG performance is driven by all the three dimensions. This finding differs from existing studies (Duque-Grisales and Aguilera-Caracuel, 2021). This finding better illustrates the substantive significance of the positive effect of ESG on stock liquidity. That is, ESG increases the level of stock liquidity as a result of the combined effect of all three dimensions: environmental, social and governance, and not as a single dimension. This suggests that ESG is an important factor driving firms to improve their

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[7] Peaking carbon dioxide emissions before 2030 and achieving carbon neutrality by 2060.

Table 8
The impact of ESG pillar on stock liquidity.

Variables	(1)	(2)	(3)
	Liquidity		
L1.*E*	0.023***		
	(4.593)		
L1.*S*		0.024***	
		(5.121)	
L1.*G*			0.031***
			(3.180)
L1.*Age*	−0.146***	−0.132***	−0.145***
	(−4.921)	(−4.451)	(−4.874)
L1.*Size*	0.526***	0.534***	0.532***
	(70.641)	(73.021)	(72.504)
L1.*SD*	−0.008***	−0.008***	−0.008***
	(−12.919)	(−12.968)	(−13.081)
L1.*Cash*	0.981***	0.976***	0.978***
	(12.843)	(12.781)	(12.760)
L1.*ROE*	0.870***	0.860***	0.864***
	(15.075)	(14.822)	(14.841)
L1.*BM*	−1.132***	−1.130***	−1.123***
	(−20.534)	(−20.536)	(−20.373)
L1.*Dual*	0.043**	0.041**	0.049***
	(2.511)	(2.357)	(2.807)
L1.*Audit*	−0.169***	−0.174***	−0.162***
	(−3.331)	(−3.411)	(−3.181)
L1.*Stdret*	0.949***	0.957***	0.952***
	(18.521)	(18.730)	(18.611)
L1.*Soe*	−0.095***	−0.088***	−0.084***
	(−4.429)	(−4.103)	(−3.925)
L1.*heavilypollution*	−0.009	−0.007	−0.003
	(−0.481)	(−0.340)	(−0.157)
Constant	−7.177***	−7.450***	−7.496***
	(−34.561)	(−35.930)	(−35.066)
Observations	6,068	6,068	6,068
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
R-squared	0.569	0.569	0.568

This table presents the grouping test results. *E, S* and *G* use the SSI (Sino-Securities Index) ESG pillar score data from Wind database. *Liquidity* is the opposite number of the illiquidity logarithm. *Age* is logarithm of the establishment period of listed company plus 1. *Size* is logarithm of the total assets of the company at the end of the year. *SD* is concentration degree of the largest shareholder. *Cash* is the ratio of cash and its cash equivalents to total assets. *ROE* is return on equity. *BM* is the ratio of the owner's equity to market value. *Dual* is the dual role of the board chairman. *Audit* is audit opinions. *Stdret* is deviation of corporate monthly return rate. *Soe* is property nature, that is state-owned enterprises are assigned a value of 1, otherwise 0. *heavilypollution* is industry nature, that is the heavy pollution industry is assigned a value of 1, otherwise 0. According to the *Guidelines for Classification of Listed Companies (Amended in 2012)*, including B06, B07, B08, B09, B10, C15, C17, C18, C19, C22, C25, C26, C27, C28, C29, C30, C31, C32, D44 are listed as heavily polluting industries. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively. t-value in bracket.

performance in the capital market.

5. Conclusions

In the past few decades, corporate ESG performance has received extensive attention from the policymakers, researchers, firms, investors and other stakeholders in the market. To learn more regarding corporate ESG performance and its economic consequences, this study investigates whether and how corporate ESG performance influences firm's stock liquidity. Using a final sample of 19,308 firm-year observations associated with 3322 listed firms in China from 2010 to 2020, we find a positive effect of corporate ESG performance in firm's stock liquidity. Such positive effect is more pronounced for state-owned enterprises (SOEs) and for those firms in heavily polluting industry. Additionally, we provide robust evidence that ESG performance increases stock liquidity by lowering corporate risk and increasing supports from stakeholders. Finally, we find that the positive effect of corporate ESG performance is driven by all the three dimensions. ESG has been actively practiced and developed in various countries as a globally recognized and important governance concept. Although the conclusion of this study was found in China's capital market, we believe that this conclusion can be generalized to other markets and provide useful suggestions.

The findings of this study are important for policymakers who regulate and design policies, and for investors or other stakeholders in the market who would like to evaluate firms' future prospects. Furthermore, the findings of this study have a few practical

implications. First of all, good corporate ESG performance is helpful to improve firm's performance in capital market. We need to fully recognize that the impact of corporate ESG performance on stock liquidity in the Chinese context is due in part to institutional pressures. Thus, government departments should strengthen policy guidance for firms, formulate support and subsidy policies to encourage corporate ESG behavior, and provide normative punishment mechanisms to prevent corporate irresponsible behavior. Specifically, such policy guidance is expected to cover details in each ESG pillar, so that the corporate ESG behavior could be more normalized.

Second, to perform better in the capital market, firms should take full advantage of ESG's role in reducing risk and gaining stakeholders' support. Firms with high-risk should consider ESG in their investment decision-making, in order to improve their anti-risk ability. SOEs should continue to play a leading role in the capital market, contributing to both economic and social benefits. Non-SOEs should take full advantage of the positive role of ESG in the capital market to improve their competitiveness. Firms in heavily polluting industry should actively practice ESG to gain support and trust from stakeholders.

Third, corporate ESG disclosure is non-financial. Therefore, it is not as easy for stakeholders to follow as other financial disclosure. To reduce information asymmetry between the firm and investors, there is a need for improving corporate disclosure mechanism and increasing information transparency. Additionally, policymakers should regulate ESG disclosure related policies, in order to increase the quality of corporate ESG disclosure. More importantly, cooperation in ESG disclosure should be enhanced across countries. Under the premise of unified standards, countries can refine the standards according to national conditions. This is important for strengthening and improving the effectiveness of ESG in practices. With the advancement of disclosure by organizations such as the Task Force on Climate-related Financial Disclosures (TCFD), we have reasons to believe that with the improvement of disclosure quality will be conducive to improving ESG practices in various countries and enhancing the vitality of companies in the capital market. It will also further promote the research related to the relationship between ESG and capital market.

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CRediT authorship contribution statement

Kai Wang: Conceptualization, Methodology, Supervision, Funding acquisition. **Tingting Li:** Data curation, Writing – original draft, Writing – review & editing. **Ziyao San:** Writing – review & editing. **Hao Gao:** Supervision, Writing – review & editing.

Declaration of Competing Interest

None.

Appendix A. Variable definitions

Variables	Definitions
ESG	Sino-Securities Index (SSI) ESG ratings.
Liquidity	The opposite number of the illiquidity logarithm.
Age	Logarithm of the establishment period of listed company plus 1.
Size	Logarithm of the total assets of the company at the end of the year.
SD	Concentration degree of the largest shareholder.
Cash	The ratio of cash and its cash equivalents to total assets.
ROE	Return on equity.
BM	The ratio of the owner's equity to market value.
Dual	1 for the dual role of the board chairman, otherwise 0.
Audit	1 for types of audit opinions other than standard unqualified opinions issued by accounting firms, otherwise 0.
Stdret	Return volatility. It is the annual standard deviation of corporate monthly return rate.
Soe	State-owned enterprises are assigned a value of 1, otherwise 0.
heavilypollution	The heavy pollution industry is assigned a value of 1, otherwise 0.
Risk	Negative return skewness coefficient for weekly stock-specific returns.
Analyst	Logarithm of the number of analysts covering the stock from CSMAR.

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