Mandatory Corporate Social Responsibility Disclosure and Stock Liquidity: Evidence from a Quasi-Natural Experiment

Abstract: This study examines the impact of mandatory corporate social responsibility (CSR) disclosure on stock liquidity by using China’s 2008 CSR reporting policy as a quasi-natural experiment and the difference-in-difference estimation approach. The results reveal that after the implementation of this policy, mandatory CSR reporting firms show substantially lower stock liquidity than non-CSR reporting firms. We further find that this effect is stronger for firms with weak corporate governance. Our paper is a supplementary argument to illiquidity premium theory and combined with risk mitigation and stakeholder theory.

Keywords: Corporate Social Responsibility; Stock liquidity; Long-term perspective; Illiquidity premium

JEL classification: G33; G34; G35; M14; M48
1. Introduction

The growing concern about sustainable economic and environmental development worldwide has triggered a trend of requiring companies to disclose their social responsibility activities (hereinafter referred to as mandatory CSR disclosure). Since the Global Economic Crisis, enterprises have been facing increasing competitive pressure and need to take a long-term perspective of investors' business interests and assume and respond to their obligations to society (Jizi et al. 2014). Although some scholars have studied the impact of CSR on the capital market through CSR performance of voluntary CSR disclosure (Bae et al. 2021; Egginton and McBreyer 2019; Harjoto and Jo 2015; Kim et al. 2014). However, such a setting inevitably has a self-selection bias of research samples and endogenous relationships among research objects (Ni and Zhang 2019; Wang and Li 2016; Wang et al. 2018). Therefore, we use China's mandatory CSR disclosure policy to conduct research in a quasi-natural experiment. Considering that liquidity is an important factor affecting investors' asset conversion ability and stock return rate (Lin et al. 2011; Subramaniam et al. 2015; Zheng et al. 2018), in this study, we investigate the potential impact of CSR on the capital market and its channels by focusing on stock liquidity.

Specifically, we examine the impact of mandatory CSR disclosure on Chinese equity liquidity. In December 2008, the Shanghai Stock Exchange (SSE) and the Shenzhen Stock Exchange (SZSE) required some Listed Chinese companies to publish independent CSR reports alongside their annual reports. This change in the CSR reporting requirement provides us with a unique setting with an exogenous shock to the subset of firms that are required to report their CSR activities. By comparing the changes in stock liquidity between the treatment group (mandatory CSR disclosure companies) and the control group (non-mandatory CSR disclosure companies) before and after the promulgation of the rule, we can conduct a difference-in-differences analysis to evaluate the impact of exogenous shock of mandatory CSR disclosure on stock liquidity. As an ex-post degree of CSR disclosure is an equilibrium outcome of firm managers' trade-off between potential benefits and costs of doing so, while ex-ante demand of CSR disclosure is hard to quantify, our setting facilitates identification of the causal effect of CSR disclosure (Ni and Zhang 2019).

Our sample includes 1,384 companies (7,437 firm-years) listed on China's Stock Exchanges between 2006 and 2011. Using the Amihud index and turnover rate as the proxy for stock liquidity, we examine the impact of mandatory CSR reporting on stock liquidity by performing a difference-

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1 We refer to the research of Chen et al. (2018) and define mandatory CSR disclosure as mandatory for companies to publicly release non-financial reports on activities related to environmental, social and governance issues. At present, the term “CSR disclosure” is often used interchangeably with “environmental, social and governance disclosure” and “non-financial disclosure”. In recent years, many countries have begun to require companies to disclose CSR information. For example, Australia, Canada and France in 2001, the United Kingdom in 2006.
in-differences analysis. We find that the stock liquidity of companies with mandatory CSR disclosure declines after disclosure regulation. Our findings are also robust to the propensity score matching approach, changing the measurement method of the explained variable (stock liquidity).

Previous studies have confirmed that CSR participation needs a long-term perspective (Chen et al. 2018; Garel and Petit-Romec 2021; Jia and Zhang 2014; Kim et al. 2019; Zhang et al. 2021). In the short term, CSR disclosure will increase enterprises' investment pressure on CSR and weaken their profitability (Chen et al. 2018; Grewal et al. 2019). However, in the long run, CSR activities can enhance the company’s long-term value through risk mitigation (Benson and Humphrey 2008) and maximizing stakeholder value (Deng et al. 2013). First, CSR disclosure can reduce information asymmetry, facilitate the supervision of managers and other stakeholders, and thus help enterprises improve governance capacity and reduce operational risks (Jizi et al. 2014; Nguyen et al. 2020). Second, according to stakeholder theory (Freeman 1984), companies that attach importance to social responsibility tend to have higher brand loyalty (Jizi et al. 2014), customer satisfaction, and employee commitment (Blasi et al. 2016). They can gain a good reputation and image by building the loyalty of their employees, customers, suppliers, and other stakeholders, thus achieving long-term returns while boosting the company's valuation (Deng et al. 2013). Therefore, we expect that corporate participation in CSR disclosure will attract more long-term investment.

We believe that the above impact of CSR disclosure on the corporate level will spread to the capital market, affecting investors' investment activities and stock liquidity. First of all, CSR disclosure makes investors chasing short-term returns leave and attracts more long-term investors. This change is due to the different investment horizons of short-term and long-term investors (Chen et al. 2018; Garel and Petit-Romec 2021). Long-term investors have more time and willingness to monitor the activities of enterprises that help maximize their long-term value and are correspondingly more interested in CSR information (Aghion et al. 2013; Gaspar et al. 2005; Kim et al. 2019). Secondly, much of the liquidity in the Chinese stock market is contributed by retail investors with a preference for short-term investments (Titman et al. 2021; Yao et al. 2019). Therefore, we believe that the departure of retail investors and the long-term holding by long-term investors will have a large negative impact on stock liquidity. Our findings can be said to be a supplement to the "illiquidity premium" (or "liquidity premium") theory (Amihud and Mendelson 1991), that is, a short horizon calls for investing in liquid assets, whereas a long investment horizon enables the investor to earn higher net returns by investing in illiquid assets. At the same time, this also confirms the view that the illiquidity premium phenomenon is more significant in the Chinese capital market (Amihud et al. 2015; Su and Mai 2004).

Furthermore, we also explore the heterogeneous effects of mandatory CSR disclosure. Since long-term investors prefer to invest in enterprises with strong governance capacity, while for
companies with weak governance, their investors should mainly be short-term investors who lack long-term perspective (Aghion et al. 2013; Jia and Zhang 2014; Kim et al. 2019). Therefore, we predict that the negative effect of mandatory CSR disclosure on stock liquidity is more significant in companies with weak governance capacity. We adopt four indicators, namely the proportion of independent directors (Jia and Tang 2018), financial analyst coverage (Dhaliwal et al. 2012), institutional shareholding (Kim et al. 2019), and audit quality (Wang et al. 2018), to represent the company's governance level. After classifying the samples according to corporate governance capacity, we find that there is a stronger main effect in the samples with less than average proportion of independent directors, the number of analysts following and institutional holdings, and those who do not employ the international Big Four accounting firms for auditing.

This study contributes to the literature in several ways. Firstly, different from the research tendency to study the impact of CSR on the capital market through CSR performance of voluntary CSR disclosure (Bae et al. 2021; Egginton and McBrayer 2019; Harjoto and Jo 2015; Kim et al. 2014), we can make use of the exogenous impact of China's mandatory CSR disclosure policy in 2008 to protect our research samples from the pollution of self-selection bias (Ni and Zhang 2019; Wang et al. 2018). Thus, the effect of mandatory CSR disclosure on stock liquidity is separated from other confounding factors (Liu and Tian 2021) through cleaner Settings. In this sense, it is innovative to study how CSR affects stock liquidity in a quasi-natural experiment.

Secondly, different from the existing studies that mostly stop at the discussion of the effectiveness of mandatory CSR disclosure policies on corporate governance (Chen et al. 2018; Liu and Tian 2021; Wang and Li 2016; Wang et al. 2018), we conduct an in-depth investigation on the relationship between mandatory CSR disclosure, corporate governance, and capital market. This study is not limited to the company level but takes stock liquidity as the entry point to see the value and effect of mandatory CSR disclosure on the capital market from a broader and grander perspective. It is of innovative and important practical value to deduce and discuss the possible economic consequences of mandatory CSR reporting, including the impact on the behavior of investors and other stakeholders, stock liquidity, and others. At the same time, we provide evidence on the impact of CSR disclosure on stock liquidity in the Chinese context, which undoubtedly increases the understanding of the economic consequences of CSR disclosure in developing countries.

Thirdly, we believe that the impact of CSR disclosure should be viewed comprehensively and dialectically. Specifically, CSR disclosure will increase the pressure on enterprises and weaken their profitability in the short term (Chen et al. 2018; Grewal et al. 2019), leading to the reduction of short-term investors. But in the long run, it will help enhance the long-term value of the company and promote its long-term development (Chen et al. 2018; Deng et al. 2013; Nguyen et al. 2020),
so it will attract more long-term investors with a long-term vision. Previous studies have placed too much emphasis on the unilateral impact of CSR disclosure. E.g., Flammer and Luo (2017), and Nguyen et al. (2020) believed that CSR disclosure is of great significance to the establishment of corporate image, improvement of governance capacity, and long-term development of a company; While both Chen et al. (2018) and Grewal et al. (2019) thought that CSR disclosure will increase cost pressure, weaken profitability, aggravate agency problems and reduce shareholder wealth. What seems to be behind the conflict of views mentioned above is the lack of a dialectical and rational view of CSR disclosure.

Finally, we contribute to the literature on the impact of CSR on the capital market. At present, there are conflicting views on the impact of CSR on the capital market. For example, Lambert et al. (2007) believed that stock returns can be improved, while Bae et al. (2021) proposed that CSR has no impact on stock returns. In this paper, we empirically find that CSR participation attracts more long-term investors, thereby reducing stock liquidity. This conclusion is not only a further discussion and supplementary argument of the "illiquidity premium" (or "liquidity premium") proposed by (Amihud and Mendelson 1991) but also a confirmation of the academic opinion that the phenomenon of illiquidity premium is relatively significant in China's capital market (Amihud et al. 2015; Su and Mai 2004; Zhang and Wang 2020).

The remainder of the paper is organized as follows. In Section 2, we review the institutional background of the mandatory CSR disclosure policy in China and discuss the related literature and our empirical prediction. Section 3 describes the data and empirical strategy of the paper. In Section 4 we report the main empirical results and robustness checks. Section 5 provides further discussions on the underlying channels of the main findings. The last section concludes the paper with contributions of our results and the main implications of our findings.

2. Institutional Background, Literature Review, and Hypothesis Development

2.1 Institutional Background on China’s CSR Reporting

As early as the second half of the 20th century, the international community began to pay attention to the mandatory disclosure of corporate social responsibility. For example, France established the first set of standardized social reporting indicators in 1977 and forced all companies with 300 or more employees to report 130 indicators related to employment activities (Jackson et al. 2020). In contrast, China's attention to mandatory disclosure of social responsibility information is relatively late. Before 2008, the China Securities Regulatory Commission only encouraged listed companies to voluntarily disclose CSR information, without specific information disclosure requirements.
The year 2008 was “the first year” of mandatory CSR disclosure in China. In December 2008, the SSE and the SZSE issued notices requiring certain companies to independently publish CSR disclosure reports in the following fiscal year². Specifically, the SSE (Shanghai Stock Exchange) requires firms listed on the SSE “Corporate Governance Sector”, firms with overseas-listed shares, and financial companies to release an annual CSR report. The SZSE (Shenzhen Stock Exchange) requires firms included in the Shenzhen 100 index to release CSR reports. These announcements indicate that firms that fail to provide reports would be subject to delisting, and such firms would be subject to public condemnation (Chen et al. 2018). In addition, other companies are encouraged to voluntarily disclose social responsibility reports and social contributions per share. As a result, China has entered a new stage where compulsory disclosure and voluntary disclosure coexist. According to the information released by the SSE and SZSE that year, 1,618 listed companies were publishing CSR reports for the fiscal year of 2008. Among the 1,618 companies, 335 companies issued the report because of the mandatory requirement while 1,283 companies did it voluntarily³.

However, mandatory CSR disclosure is different from voluntary CSR disclosure. This is because the mandatory disclosure policy specifies in detail the standards and ways of CSR disclosure (Wang et al. 2018). Compared with mandatory CSR reports, voluntary CSR information disclosed by enterprises is usually less comprehensive and covers a lower depth of social responsibility activities (Dhaliwal et al. 2011). Therefore, the information quality and validity of voluntary CSR disclosure cannot be comparable to mandatory CSR disclosure. This is why we are focusing on mandatory CSR disclosure.

2.2 Theoretical Analysis and Hypothesis Development

The relationship between CSR and the capital market has always attracted academic attention. (Kim et al. 2014) found that CSR performance can reduce stock price crash risk, and the mitigation effect is more obvious when corporate governance efficiency or institutional ownership level is low. In 2015, (Harjoto and Jo 2015) pointed out that overall CSR activities reduce the dispersion of analysts, the volatility of stock returns, and the hidden cost of equity capital while contributing to the improvement of corporate value. In 2017, (Harjoto et al. 2017) again showed that CSR activities can indirectly reduce corporate risk (i.e., stock return volatility) through institutional ownership until institutional investors consider CSR activities to be optimal. However, in reviewing relevant literature, we find that there are few kinds of literature involving stock liquidity. Currently, only

² Given that China's SSE and SZSE are wholly owned by the government and overseen directly by the CSRC, this policy is essentially a government requirement.
³ The CSR report disclosure data in this study are mainly manually sorted out from the website of Shenzhen Securities Information Co., Ltd. (www.cninfo.com.cn) (CNINFO), which is the official website authorized by the China Securities Regulatory Commission (CSRC) to disclose Chinese listed companies’ announcements and reports.
Egginton and McBrayer (2019) discussed the impact of CSR on stock liquidity, and they found that equity market liquidity improves as firms increase their CSR disclosure transparency.

Our study is related to, but different from, Egginton and McBrayer (2019). Specifically, (Egginton and McBrayer 2019) used CSR performance to characterize the transparency of CSR disclosure, while we investigated the economic impact of mandatory CSR disclosure events. CSR performance is different from CSR disclosure. Companies with excellent CSR performance do not necessarily disclose more CSR-related information (Al-Tuwaijri et al. 2004; Richardson et al. 1999; Wang et al. 2018). At the same time, with the exogenous impact of mandatory CSR reporting, we can also study the relationship between CSR disclosure and stock liquidity without the pollution of self-selection bias (Ni and Zhang 2019; Wang and Li 2016; Wang et al. 2018), and then deduce and discuss the possible economic consequences of CSR reporting tasks, including the potential capital market impact.

Some studies have investigated the relationship between CSR performance and capital markets and come to inconsistent conclusions. Anderson and Frankle (1980) found that companies that made social report disclosure performed better in the stock market than those that did not. Servaes and Tamayo (2013) also showed that CSR does increase the market value of companies with high customer awareness. At the same time, Lambert et al. (2007) pointed out that mandatory disclosure of non-financial information increases the availability of information related to stock prices for monitoring purposes, and may increase stock returns. However, Orlitzky (2013) believes that organizational signals about corporate social responsibility may hurt equity markets. Specifically, instead of functioning as an effective private governance mechanism, CSR may exacerbate the excessive volatility and stock price bubbles of the stock market because it amplifies the noise of the stock market (Orlitzky 2013). Then, when CSR plays a role in stock return and stock market volatility, what impact will it have on stock liquidity?

Furthermore, we believe that CSR participation will reduce stock liquidity while increasing stock returns (Lambert et al. 2007), alleviating stock market volatility (Harjoto et al. 2017) and stock price crash risk (Kim et al. 2014). Empirical evidence shows that higher expected returns on stocks tend to be less liquid (Amihud and Mendelson 1991). Of course, this does not necessarily mean investors are better off holding less liquid assets, as higher transaction costs eat into the return gains. Rather, the aim is to emphasize that short-term investments tend to be in liquid assets, while long-term investments can earn higher returns by investing in illiquid assets (Amihud and Mendelson 1991; Atkins and Dyl 1997; Datar et al. 1998; Korajczyk and Sadka 2008). China's stock market has long been dominated by small and medium-sized investors, or "retail investors", who trade frequently and seek short-term profits. This has led to a more liquid stock market compared with developed markets (Nartea et al. 2017). But retail investors are always considered to be noise
traders, and they are also mostly short-term investors (Black 1986; Kyle 1985). Therefore, we expect that as CSR investment increases, they will choose to withdraw and leave, resulting in lower liquidity. At the same time, CSR will also attract more long-term investment in the process of reducing stock market volatility and crash risk, thus further reducing liquidity. The above discussion leads to our first hypothesis:

**H1**: The mandatory CSR disclosure will reduce the stock liquidity of enterprises.

Previous studies have shown that justifying a commitment to CSR requires a long-term perspective (Chen et al. 2018; Garel and Petit-Romec 2021; Jia and Zhang 2014; Kim et al. 2019). Because CSR disclosure will enhance information transparency, it means that enterprises need to increase their commitment to CSR, which will increase their pressure, weaken profitability, aggravate agency problems, and reduce shareholder wealth in the short term (Chen et al. 2018; Grewal et al. 2019). However, CSR reporting can alleviate information asymmetry between managers, investors, and other stakeholders (e.g., suppliers, customers, employees, creditors, and the entire community). While reducing their worries about the uncertain future operation of the enterprise, it also helps them to supervise and control the company's behavior and decision-making, and improve the company's governance ability (Jamali et al. 2008; Jizi et al. 2014; Nguyen et al. 2020). In addition, CSR involvement can build a good reputation, reflect the integrity and credibility of managers (e.g., shareholder relations, creditor relations, and employee relations) (Elfenbein et al. 2012; Wang et al. 2018) and enhance company valuation (Chen et al. 2018; Garel and Petit-Romec 2021). Based on the above analysis, it is reasonable to believe that the improvement of corporate governance capacity and reputation will attract more long-term investment.

Existing studies further prove that enterprises with CSR disclosure will reduce short-term investors and attract more long-term investors (Aghion et al. 2013; Gaspar et al. 2005; Kim et al. 2019). This is mainly because, contrary to short-term investors who pursue short-term financial returns, long-term investors have a longer perspective and hope to obtain excess profits through long-term equity holding. Therefore, they pay more attention to investment activities that help to maximize the long-term value of the company (Jia and Zhang 2014; Kim et al. 2019). In other words, their long-term ownership gives them a strong motivation to monitor enterprises to reduce operational risks and enhance the corporate image with the help of CSR information, while short-term investors lack such time and incentives (Gaspar et al. 2005). Kim et al. (2019) empirically found that long-term institutional ownership promotes firms’ CSR activities, while short-term institutional ownership hinders them. According to this logic, we infer that CSR participation will attract more long-term investors, while their long-term holding and less trading will also reduce stock liquidity. In addition, given that companies with weak internal governance capacity tend to have more severe information asymmetry and agency problems and fewer long-term investors
Therefore, referring to the research of (Harford et al. 2018), we predict that the impact of mandatory CSR disclosure on companies with weak corporate governance capacity should be more pronounced, that is, showing a stronger main effect. This leads to our second hypothesis:

H2: For enterprises with poor corporate governance, mandatory CSR disclosure has a more significant negative effect on reducing stock liquidity.

3. Research Design

3.1 Model specification and Variable Definitions

To better isolate the impact of mandatory CSR disclosure on stock liquidity, we employ a difference-in-differences specification (DID) by comparing the changes in stock liquidity surrounding the issuance of the mandatory CSR disclosure regulation in mandatory CSR firms with those in nondisclosure firms. The DID method can alleviate the endogeneity problem (Wang et al. 2018) in the study through a clearer setting (quasi-natural experiment), and distinguish the effect of mandatory CSR disclosure on stock liquidity from other confounding factors (Liu and Tian 2021).

Specifically, we estimate the following model to test our hypothesis:

\[
\text{Liquidity}_{i,t} = \beta_0 + \beta_1 \text{Treated}_{i,t} \times \text{Period}_{i,t} + \beta_2 \text{Treated}_{i,t} + \beta_3 \text{Period}_{i,t} + \beta_4 \text{Z}_{i,t} + \epsilon_{i,t} \tag{5}
\]

Here, \(\text{Treated}_{i,t} \times \text{Period}_{i,t}\) is the core explanatory variable that this study mainly focuses on, and the influence of mandatory CSR disclosure on stock liquidity is evaluated by observing its coefficient \(\beta_1\). Among them, the dummy variable \(\text{Treated}_{i,t}\) indicates whether the enterprise belongs to the experimental group: \(\text{Treated} = 1\) represents mandatory CSR reporting firms, \(\text{Treated} = 0\) represents non-CSR reporting firms. The dummy variable \(\text{Period}_{i,t}\) refers to the time before and after the mandatory CSR disclosure policy is issued. \(\text{Period}_{i,t}\) equal to one if it is the year 2009 or after, and zero otherwise.

The explained variable in this paper is stock liquidity (\(\text{Liquidity}_{i,t}\)). Based on daily transaction data measurement, we select two proxy variables: market illiquidity indicator (\(\text{Amihud}\)) and turnover rate (\(\text{Turnover}\)), respectively from the transaction cost dimension and transaction time dimension. Amihud index proposed by Amihud (2002) is the most representative market shock indicator, which is the ratio of stock return rate to trading volume over a while to measure the sensitivity of stock price to trading volume. Since the Amihud index is an illiquid indicator, for the convenience of expression, we multiplied the Amihud index by -1 and treated it as a positive indicator (\(\text{Amihud}\)). Therefore, in the following, the smaller \(\text{Amihud}\), the worse the
liquidity. Referring to Zheng et al. (2018), we use \( \text{Return}_{i,d} \) to represent the return rate of \( i \) stock on the day of \( d \) trading day, and \( \text{Volume}_{i,d} \) to represent the trading volume of \( i \) stock on the day of \( d \) trading day. The measurement method of this indicator is as follows:

\[
\text{Amihud}_{i,d} = \ln(10^6 \times \frac{|\text{Return}_{i,d}|}{\text{Volume}_{i,d}} + 1) \times (-1)
\]  

(1)

The turnover rate is an important indicator to measure stock liquidity. The greater the turnover rate, the greater the depth of the market and the better the stock liquidity. In this paper, the calculation method of the turnover rate of \( i \) stock on trading day is shown in Formula (2):

\[
\text{Turnover}_{i,d} = \frac{\text{stock turnover of } i}{\text{the number of shares outstanding}}
\]  

(2)

Referring to the studies of (Wang and Li 2016), (Wang et al. 2018), and (Gong et al. 2021). We also include a vector of control variables \( Z_{i,t} \) in the model, which includes Firm size, Operating revenue, Firm age, Cash, EBITDA margins, Debt to Asset Ratio, Tobin's Q, and Capital Expenditure. See Table 1 for the index definition and attribute of main variables in this paper.

3.2 Data Source and Sample Selection

We obtain financial data of listed companies and daily low-frequency data to measure liquidity from the CSMAR database and high-frequency data to measure liquidity from RESSET database. Our initial sample includes all companies listed on the Shanghai and Shenzhen stock exchanges between 2006 and 2011. We excluded a total of 140 B-share (foreign equity) companies and other overseas stock companies, because they are subject to different regulatory and market trading mechanisms. At the same time, we also shot to exclude the backdoor listing in the window period of 5 companies, because they will fundamentally affect the liquidity of the company. In addition, referring to X. Wang et al. (2018), we excluded 43 companies that voluntarily issued CSR reports during the sample period. After excluding the aforementioned types of companies, the sample number of remaining companies is 1384. Please refer to the appendix for the distribution of total samples.

3.3 Descriptive Statistics

Table 2 reports the results of descriptive statistics for the main variables in this paper. To eliminate the influence of extreme values on the results of this paper, we winsorize continuous
variables at 1% and 99% levels. The descriptive statistical results of the main variables involved in regression are shown in Table 5, with a total sample size of 7437.

[Insert Table 2]

4. Empirical Results and Analysis

4.1 Results of Empirical Analyses

Table 3 reports linear estimates of the impact of mandatory CSR disclosure on stock liquidity. Among them, columns 1 and 2 do not control for fixed effects, while columns 3 and 4 control the annual, industry, and province fixed effects. Empirical results show that no matter the dependent variable is Amihud or Turnover, the coefficient Treated * Period is negative and significant at 1%. This suggests that after mandatory CSR disclosure, the stock liquidity of the processing group companies has decreased, and thus H1 is supported.

To interpret the economic significance of our results, compared with the control group, the enactment of mandatory CSR disclosure leads to 69.3% (=0.138*100%/0.199), 25.7% (=0.165*100%/0.641), 71.4% (=0.142*100%/0.199) and 31.8% (=0.204*100%/0.641) decrease in stock liquidity corresponding to the sample mean in columns (1), (2), (3) and (4), respectively. In general, our results show that mandatory CSR disclosure is associated with lower stock liquidity across the two measures of stock liquidity.

[Insert Table 3]

4.2 Robustness Tests

Different from the intra-day low-frequency trading environment, liquidity measurement in a high-frequency trading environment should take into account not only transaction size, transaction cost and other factors, but also the Price Impact of the transaction (Kyle 1985; O’Hara 2003; Stoll 2000). Therefore, in the robustness test, we introduce Relative Spread (ReSpread) and Relative Effective Spread (ReEffSpread) in the high-frequency trading environment, and use them as dependent variables to observe the impact of mandatory CSR disclosure on stock liquidity. We used the high-frequency trading and quotation data of each transaction during in the trading time of each trading day (9:30:00-15:00:00) for measurement:

\[
ReSpread_{i,a} = \frac{(ask - bid)}{(ask + bid)/2} \times (-1)
\]  

(3)
Where \( \text{ask} \) is the selling price closest to the transaction price, \( \text{bid} \) is the purchase price closest to the transaction price, and \( \text{price} \) is the transaction price. Similar to the Amihud index, Relative Spread and Relative Effective Spread are also illiquid indicators. To facilitate understanding and expression, we also multiplied them by \(-1\) to treat them as positive indicators. Therefore, in this study, the smaller Relative Spread (\( \text{ReSpread} \)) and Relative Effective Spread (\( \text{ReEffSpread} \)), the worse the liquidity. The empirical results are shown in Table 4. Among them, columns (1) and (2) do not control the fixed effects, while columns (3) and (4) control the fixed effects of the year, industry and province. The empirical results show that no matter what the dependent variables are \( \text{ReSpread} \) and \( \text{ReEffSpread} \), the coefficients of \( \text{Treated} \times \text{Period} \) are negative and significant at the level of 1%. The results also confirm that mandatory disclosure of CSR reports reduces stock liquidity.

\[
\text{ReEffSpread}_{i,t} = \left| \frac{\text{price} - \frac{\text{ask} + \text{bid}}{2}}{\frac{\text{ask} + \text{bid}}{2}} \right| \times (-1) \tag{4}
\]

4.3 Propensity Score Matching (PSM)

The difference-in-differences analysis method can control the unobservable fixed effects to some extent and overcome the endogeneity problem. Furthermore, to solve the problem of "selection bias" in samples and ensure the comparability between the treatment group and the control group, we construct a propensity score-matched sample and re-estimate the effect we document in previous sections (Ni and Zhang 2019; Wang et al. 2018). The procedure of selecting the control group of the matched sample is as follows. Following Ni and Zhang (2019), we first apply a Logit regression model to estimate the probability of being a treatment firm using the preregulation period data. Please refer to the appendix for the regression result and analysis. Next, to ensure that there is no difference between groups after each variable is matched, the balance test is presented in the appendix. Generally speaking, the standardized deviation of variables after matching is less than 10%, indicating that there is no significant systematic deviation between the experimental group and the control group, thus achieving a good matching effect.

After successfully constructing the propensity score-matched sample, we re-estimated the specific empirical results in the above benchmark regression and high-frequency trading environment and reported the estimated results in Table 5. Columns (1) - (4) report the regression results of the Amihud index (\( \text{Amihud} \)) and turnover rate (\( \text{Turnover} \)) as dependent variables in the low-frequency trading environment. Columns (5) - (6) report the regression results of Relative
Spread \( (ReSpread) \) and Relative Effective Spread \( (ReEffSpread) \) as dependent variables in the high-frequency trading environment. Columns (1), (2), (5), and (6) do not control the year, industry and province, but columns (3), (4), (7) and (8) do. The empirical results show that the coefficient is significantly negative in both low frequency and high-frequency trading environments. Again, the results of basic regression are accurate and reliable.

[Insert Table 5]

5. Further Analysis

In this section, we explore cross-sectional differences in corporate governance capacity to test for the underlying channels of the negative effects of mandatory CSR disclosure and stock liquidity. Existing studies show that CSR participation of enterprises will reduce short-term investors and attract more long-term investors (Aghion et al. 2013; Gaspar et al. 2005; Kim et al. 2019). Given that enterprises with poor internal governance lack long-term investors (Harford et al. 2018; Jizi et al. 2014; Ni and Zhang 2019), we predict that mandatory CSR disclosure will have a more significant negative effect on reducing stock liquidity for enterprises with poor corporate governance. In other words, our main effects should be more pronounced for firms with weaker internal governance.

To test the accuracy of the above prediction, we select the following four indicators to describe corporate governance capacity: Firstly, the proportion of independent directors, that is, the proportion of independent directors in the number of directors (Jia and Tang 2018). We maintain that if the proportion of independent directors exceeds the industry average this year, the company will have a good internal governance level. Secondly, financial analyst coverage (the number of financial analysts following a firm) (Dhaliwal et al. 2012). We believe that if the number of tracking analysts exceeds the average level of the industry this year, the external governance level is better. Thirdly, institutional shareholding (Kim et al. 2019). Our view is that if the holding of institutional positions in the enterprise exceeds the average level of the industry in that year, it means that the enterprise has a better external governance level. Fourthly, audit quality (whether to employ the Big Four accounting firms for auditing) (Wang et al. 2018). Given the stricter auditing requirements of the Big Four accounting firms, we consider the listed companies that employ the Big Four accounting firms for auditing as having a better external governance level. This study classifies the samples according to the above four indicators of corporate governance. Meanwhile, to ensure the robustness of the results, two methods of DID and PSM-DID were adopted for verification.

In Table 6, we examine whether corporate governance capacity makes a difference in the effect of mandatory CSR disclosure. In Panel A, we use the proportion of independent directors as the
dividing standard. As can be seen from the empirical results, the coefficient of $Treated * Period$ is negative at the significance level of 1% regardless of whether it is above ($High$) or below ($Low$) the threshold level of this categorical variable. However, it can also be observed that the absolute value of the negative coefficient of $Treated × Period$ is larger for enterprises below ($Low$) the threshold level of the proportion of independent directors (the coefficient in columns (1) - (4) is compared with the empirical results in columns (5) - (6) respectively). That is, in the sample with relatively weak governance ($Low$), we get a more significant main effect. This finding is also true in Panel B and Panel C. However, in Panel D, which is based on Audit quality: Whether the Big Four accounting firms are hired ($EBF$) or not ($Non−EBF$), the coefficient of $Treated × Period$ in columns (6) and (8) is not significant, indicating that after hiring the Big Four accounting firms ($EBF$), the negative impact of mandatory CSR disclosure on stock turnover rate can be cracked. This result reinforces our prediction.

In summary, consistent with our conjecture, these findings suggest that the decrease in stock liquidity induced by mandatory CSR disclosure is more pronounced for firms with weaker corporate governance, i.e., $H2$ holds.

[Insert Table 6]

6. Discussion and Conclusion

This study reveals the impact of mandatory CSR disclosure on stock liquidity through a quasi-natural experiment. In 2008, China's SSE and SZSE required certain companies to disclose CSR reports. Under the impact of this exogenous regulatory policy, we find that the stock liquidity of companies forced to disclose CSR reports decreased. Our findings are robust to the Propensity-Score-Matching approach and alternative measure of stock liquidity. Further analysis shows that the negative correlation is more obvious for companies with weak corporate governance mechanisms. This is mainly because investors in companies with weaker governance levels are mainly short-term investors who lack a long-term perspective. Under the influence of this policy, the uncertainty of short-term income expectations will cause them to give up equity holdings.

Our research has important theoretical value. First, mandatory CSR disclosure has a significant negative impact on stock liquidity. In other words, mandatory CSR disclosure will make short-term holders who pursue short-term returns leave the market and attract more long-term holders who have a long-term vision and pursue long-term returns, resulting in declining stock liquidity and increasing illiquidity premium (or liquidity premium). Second, for companies with weak corporate governance mechanisms, the negative correlation between mandatory CSR disclosure and stock liquidity is more significant, that is, for companies lacking long-term investors, the short-term loss of interests under the effect of this policy is more significant. Third, our research proves that there
is indeed a relatively significant illiquidity premium phenomenon in the Chinese market, which is also a supplementary demonstration to the illiquidity premium theory. It also provides a unique long-term dialectical perspective on mandatory CSR disclosure, that is, it benefits companies, stakeholders and even the capital market in the long run at the expense of short-term interests.

In addition, our findings have important practical value for the perfection and development of the capital market. The results show that regulators can strengthen supervision by requiring enterprises to disclose non-financial information, optimize the investor structure in China, cultivate real long-term investors, and alleviate the wind of short-term speculation and gambling speculative preference in the Chinese stock market. In addition, stakeholders can also exercise their supervisory powers through CSR disclosure to reduce the occurrence of conflict of interest and loss of interest under information asymmetry. To achieve the maximum consistency of interests between the company and its stakeholders.

Of course, our work is not without limits. First, this study only focuses on the effect of mandatory CSR disclosure but ignores the effect of CSR performance and voluntary CSR disclosure. Therefore, there is a lack of comprehensive evaluation of the effect of CSR on shareholder welfare and investor behavior. Second, it remains to be seen whether our results can be generalized and applied to other countries, given the increasing differences in development status and institutional environment among countries. Our future research will be based on a global perspective to the greatest extent and will improve and supplement the results of this study by evaluating the effectiveness of CSR disclosure systems in other countries.
References


Table 1. Variable definitions

<table>
<thead>
<tr>
<th>Variable name</th>
<th>Variable definitions</th>
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<tbody>
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<td>Amihud</td>
<td>See Formula (1)</td>
</tr>
<tr>
<td>Turnover</td>
<td>See Formula (2)</td>
</tr>
<tr>
<td>ReSpread</td>
<td>See Formula (3)</td>
</tr>
<tr>
<td>ReEffSpread</td>
<td>See Formula (4)</td>
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<tr>
<td>Firm size</td>
<td>The logarithm of the market value</td>
</tr>
<tr>
<td>Operating revenue</td>
<td>The logarithm of operating revenue</td>
</tr>
<tr>
<td>Firm age</td>
<td>The logarithm of Firm age</td>
</tr>
<tr>
<td>Cash</td>
<td>Cash flow / Total assets</td>
</tr>
<tr>
<td>EBITDA margins</td>
<td>EBITDA / Operating income</td>
</tr>
<tr>
<td>Debt to Asset Ratio</td>
<td>Total liability / Total assets</td>
</tr>
<tr>
<td>Tobin’s Q</td>
<td>The market value / Assets’ replacement cost</td>
</tr>
<tr>
<td>Capital Expenditure</td>
<td>Capital expenditure / Previous year’s total assets</td>
</tr>
</tbody>
</table>

Table 2. Descriptive statistics

<table>
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<tr>
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<th>Count</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
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<td>0.199</td>
<td>-2.036</td>
<td>-0.004</td>
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<td>-0.061</td>
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<td>ReEffSpread</td>
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<td>0.176</td>
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<td>-0.061</td>
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<tr>
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<td>21.000</td>
<td>1.499</td>
<td>16.092</td>
<td>25.187</td>
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<td>2.200</td>
<td>0.577</td>
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<td>0.116</td>
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<td>0.604</td>
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<td>0.241</td>
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<td>27.616</td>
</tr>
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<td>3.520</td>
<td>5.775</td>
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<td>50.873</td>
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</table>

This table reports the descriptive statistics on the firm characteristics of the sample. Variable definitions are in Table 1. All continuous variables are winsorized at the 1st and 99th percentiles.
Table 3. Benchmark regression results

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<th>(3)</th>
<th>(4)</th>
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<td>Amihud</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turnover</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treated*Period</td>
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<td>-0.165***</td>
<td>-0.142***</td>
<td>-0.204***</td>
</tr>
<tr>
<td>(0.009)</td>
<td>(0.033)</td>
<td>(0.009)</td>
<td>(0.030)</td>
<td></td>
</tr>
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<td>-0.401***</td>
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<td>(0.004)</td>
<td>(0.016)</td>
<td>(0.007)</td>
<td>(0.031)</td>
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</tr>
<tr>
<td>Treated</td>
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<td>0.013</td>
<td>0.083***</td>
<td>0.045</td>
</tr>
<tr>
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<td>(0.025)</td>
<td>(0.006)</td>
<td>(0.029)</td>
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<tr>
<td>Firm size</td>
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<td>-0.128***</td>
<td>0.051***</td>
<td>-0.164***</td>
</tr>
<tr>
<td>(0.003)</td>
<td>(0.012)</td>
<td>(0.005)</td>
<td>(0.018)</td>
<td></td>
</tr>
<tr>
<td>Operating revenue</td>
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<td>0.002</td>
<td>0.015***</td>
<td>-0.002</td>
</tr>
<tr>
<td>(0.002)</td>
<td>(0.009)</td>
<td>(0.003)</td>
<td>(0.016)</td>
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</tr>
<tr>
<td>Firm age</td>
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<td>-0.178***</td>
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<td>-0.082***</td>
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<td>(0.003)</td>
<td>(0.013)</td>
<td>(0.005)</td>
<td>(0.020)</td>
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<tr>
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<td>-0.374***</td>
<td>0.028</td>
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<tr>
<td>(0.017)</td>
<td>(0.066)</td>
<td>(0.020)</td>
<td>(0.084)</td>
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<tr>
<td>EBITDA margins</td>
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<td>0.000</td>
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<td>0.001</td>
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<tr>
<td>(0.000)</td>
<td>(0.001)</td>
<td>(0.000)</td>
<td>(0.001)</td>
<td></td>
</tr>
<tr>
<td>Debt to Asset Ratio</td>
<td>-0.173***</td>
<td>-0.043</td>
<td>-0.151***</td>
<td>-0.017</td>
</tr>
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<td>(0.008)</td>
<td>(0.031)</td>
<td>(0.015)</td>
<td>(0.042)</td>
<td></td>
</tr>
<tr>
<td>Tobin's Q</td>
<td>0.015***</td>
<td>0.004</td>
<td>0.005**</td>
<td>-0.070***</td>
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<tr>
<td>(0.001)</td>
<td>(0.004)</td>
<td>(0.002)</td>
<td>(0.007)</td>
<td></td>
</tr>
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<td>Capital Expenditure</td>
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<td>(0.024)</td>
<td>(0.093)</td>
<td>(0.026)</td>
<td>(0.102)</td>
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<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Industry FE</td>
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<td>No</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Province FE</td>
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<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
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<td>-1.628***</td>
<td>5.565***</td>
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<td>(0.042)</td>
<td>(0.159)</td>
<td>(0.080)</td>
<td>(0.358)</td>
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<td>Observations</td>
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<td>7437</td>
<td>7437</td>
<td>7437</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.380</td>
<td>0.138</td>
<td>0.448</td>
<td>0.482</td>
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</table>

This table reports the results of the OLS regressions of alternative measures of employee-related CSR on long-term ownership and control variables. Columns (1) and (2) do not control for fixed effects while columns (3) and (4) control for the year, industry, and province fixed effects. In columns (1) and (3), the dependent variable is the Amihud index. In columns (2) and (4), the dependent variable is turnover rate. Variable definitions are in Table 1. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are reported in parentheses. The superscripts ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.
Table 4. *ReSpread* and *ReEffSpread* as alternative measures of stock liquidity (high-frequency trading environment)

<table>
<thead>
<tr>
<th>Variables</th>
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<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Treated*Period</strong></td>
<td>-0.045***</td>
<td>-0.069***</td>
<td>-0.049***</td>
<td>-0.073***</td>
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<tr>
<td></td>
<td>(0.004)</td>
<td>(0.008)</td>
<td>(0.004)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Period</td>
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<td>0.119***</td>
<td>0.112***</td>
<td>0.107***</td>
</tr>
<tr>
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<td>(0.002)</td>
<td>(0.004)</td>
<td>(0.005)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Treated</td>
<td>0.034***</td>
<td>0.048***</td>
<td>0.039***</td>
<td>0.049***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.006)</td>
<td>(0.004)</td>
<td>(0.007)</td>
</tr>
<tr>
<td>Firm size</td>
<td>0.021***</td>
<td>0.039***</td>
<td>0.017***</td>
<td>0.031***</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.003)</td>
<td>(0.002)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>Operating revenue</td>
<td>0.010***</td>
<td>0.010***</td>
<td>0.009***</td>
<td>0.009***</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.002)</td>
<td>(0.001)</td>
<td>(0.003)</td>
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<tr>
<td>Firm age</td>
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<td>0.009***</td>
<td>0.000</td>
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<td>(0.001)</td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>Cash</td>
<td>-0.006</td>
<td>-0.054***</td>
<td>0.022*</td>
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<td></td>
<td>(0.007)</td>
<td>(0.017)</td>
<td>(0.011)</td>
<td>(0.020)</td>
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<tr>
<td>EBITDA margins</td>
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<td>-0.001*</td>
<td>-0.001***</td>
<td>-0.000*</td>
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<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>Debt to Asset Ratio</td>
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<td>-0.067***</td>
<td>-0.100***</td>
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<td>(0.008)</td>
<td>(0.006)</td>
<td>(0.012)</td>
</tr>
<tr>
<td>Tobin's Q</td>
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<td>0.012***</td>
<td>0.002**</td>
<td>-0.001</td>
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<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
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<tr>
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<td>0.033**</td>
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<td>(0.031)</td>
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<td>Yes</td>
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<td>Yes</td>
</tr>
<tr>
<td>Province FE</td>
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<td>Yes</td>
<td>Yes</td>
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<td>-0.892***</td>
<td>-1.334***</td>
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<td>7437</td>
<td>7437</td>
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<tr>
<td>R-squared</td>
<td>0.469</td>
<td>0.255</td>
<td>0.469</td>
<td>0.255</td>
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</table>

This table reports the regression results of the impact of mandatory CSR disclosure on stock liquidity in the high-frequency trading environment. Stock liquidity is represented by Relative Spread (*ReSpread*) and Relative Effective Spread (*ReEffSpread*) (Kyle 1985; O’Hara 2003; Stoll 2000). Variable definitions are in Table 1. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are reported in parentheses. The superscripts ***,**, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.
Table 5. The propensity-score-matching approach

<table>
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<th>high-frequency trading environment</th>
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<td>Amihud Turnover Amihud Turnover</td>
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<td>ReEffSpread</td>
<td>ReSpread</td>
<td>ReEffSpread</td>
<td>ReSpread</td>
</tr>
<tr>
<td></td>
<td>(1)   (2)   (3)   (4)</td>
<td>(5)   (6)   (7)   (8)</td>
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<td></td>
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<tr>
<td>Treated Period</td>
<td>0.119*** 0.130*** 0.126*** 0.171***</td>
<td>-0.038***</td>
<td>-0.058***</td>
<td>-0.044***</td>
<td>-0.064***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.009) (0.034) (0.010) (0.031)</td>
<td>(0.004) (0.009) (0.004) (0.007)</td>
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<td></td>
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</tr>
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<td>Period</td>
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<td>0.101***</td>
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<tr>
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<td>(0.005) (0.018) (0.008) (0.034)</td>
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<tr>
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<td>0.042***</td>
<td>0.036***</td>
<td>0.045***</td>
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<tr>
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<td>(0.006) (0.026) (0.006) (0.030)</td>
<td>(0.003) (0.006) (0.004) (0.007)</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Firm size</td>
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<td>0.022***</td>
<td>0.042***</td>
<td>0.017***</td>
<td>0.033***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.003) (0.013) (0.005) (0.021)</td>
<td>(0.001) (0.003) (0.003) (0.005)</td>
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</tr>
<tr>
<td>Operating revenue</td>
<td>0.011*** 0.006 0.010*** 0.005</td>
<td>0.008***</td>
<td>0.006**</td>
<td>0.008***</td>
<td>0.008**</td>
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<td>(0.001) (0.002) (0.002) (0.003)</td>
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<td>0.003</td>
<td>0.000</td>
<td>0.017***</td>
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<tr>
<td></td>
<td>(0.004) (0.016) (0.005) (0.023)</td>
<td>(0.002) (0.004) (0.003) (0.006)</td>
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</tr>
<tr>
<td>Cash</td>
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<td>-0.043**</td>
<td>0.019</td>
<td>0.011</td>
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</tr>
<tr>
<td></td>
<td>(0.018) (0.072) (0.019) (0.096)</td>
<td>(0.008) (0.018) (0.013) (0.022)</td>
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<td></td>
</tr>
<tr>
<td>EBITDA margins</td>
<td>-0.001* 0.001 -0.001** 0.001</td>
<td>-0.001*</td>
<td>-0.001**</td>
<td>-0.001***</td>
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<td>(0.009) (0.034) (0.013) (0.046)</td>
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<td>Tobin’s Q</td>
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<td>Capital Expenditure</td>
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This table presents the estimation results using the propensity-score-matched sample as the control group. Columns (1) - (4) report the test results of the fundamental regression (low-frequency trading environment). Columns (5) - (8) report the results using alternative Dependent variables (high-frequency trading environment). Columns (1), (2), (5), and (6) do not control the fixed effects, while columns (3), (4), (7) and (8) control the year, industry and province fixed effects. Variable definitions are in Table 1. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are reported in parentheses. The superscripts ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 6. Cross-sectional analysis

Panel A: The proportion of independent directors

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<tr>
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<td>(4)</td>
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<td>(8)</td>
</tr>
<tr>
<td>Treated*Period</td>
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<td>(0.042)</td>
<td>(0.011)</td>
<td>(0.050)</td>
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<tr>
<td>Treated</td>
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<td>0.071*</td>
<td>0.068***</td>
<td>0.079*</td>
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<td>(0.012)</td>
<td>(0.026)</td>
<td>(0.017)</td>
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### Panel B: Financial analyst coverage (the number of financial analysts following a firm)

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<td><strong>DID</strong></td>
<td><strong>PSM-DID</strong></td>
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<td>Turnover</td>
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<td>(6)</td>
<td>(7)</td>
<td>(8)</td>
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<tr>
<td>Treated*Period</td>
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<td>-0.208***</td>
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<td>(0.037)</td>
<td>(0.007)</td>
<td>(0.036)</td>
</tr>
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<td>Period</td>
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<td>(0.041)</td>
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<td>0.047***</td>
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*(All coefficients are statistically significant at the 1% level, unless otherwise noted.)*
Panel C: Institutional shareholding

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<td>Amihud</td>
<td>Turnover</td>
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Panel D: Audit quality (whether to employ the Big Four accounting firms for auditing)

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<th>Non-EBF</th>
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</table>
This table examines the effect of mandatory corporate social responsibility (CSR) disclosure on stock liquidity through cross-sectional analysis. Panel A reports the influence of the proportion of independent directors on the main effect. Panel B reports the impact results of financial analyst coverage on the main effect. Panel C reports the results of institutional shareholding's impact on the main effect. Panel D reports the impact results of whether to employ the Big Four accounting firms on the main effect. Among them, dependent variables Amihud and Turnover refer to the Amihud index and turnover rate respectively. Treated*Period is the main independent variable of concern. Low indicates that it is lower than the industry average in the year, and High indicates that it is higher than the industry average in the year (that is, the arithmetic average is the threshold). EBF and Non-EBF stand for the Big Four accounting firms employed and not employed respectively. In cross-sectional analysis, both DID and PSM-DID are used for verification. All regressions control for the year, industry, and province fixed effects. Variable definitions are in Table 1. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are reported in parentheses. The superscripts ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

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<td>6016</td>
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<td>R-squared</td>
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<td>0.648</td>
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Appendix:

Table A1. Total sample distribution statistics

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<th></th>
<th>Control</th>
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<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
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<td>1101</td>
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<tr>
<td>2008</td>
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<td>283</td>
<td>16.86%</td>
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<tr>
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<td>282</td>
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<td>17.68%</td>
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<tr>
<td>2011</td>
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<td>17.39%</td>
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<td>16.74%</td>
<td>1031</td>
<td>17.58%</td>
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<tr>
<td>Total</td>
<td>7544</td>
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<td>1679</td>
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<td>5865</td>
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Table A2. Logit regression model results

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<tr>
<td>EBITDA margins</td>
<td>0.447 (0.82)</td>
</tr>
<tr>
<td>Turnover rate</td>
<td>0.00537 (0.02)</td>
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<tr>
<td>Return on investment</td>
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This table presents the estimation results using the Logit model. Following Ni and Zhang (2019), we first apply a Logit regression model to estimate the probability of being a treatment firm using the preregulation period data. Similar to Ni and Zhang (2019), we regress the probability of being a treatment firm on the following explanatory variables: Firm size, EBITDA margins, Turnover rate, Return on investment, State ownership, Political connections (whether there are political connections among senior management), Financial analyst coverage (the number of financial analysts following a firm), The heavily polluting industry (whether the company belongs to the heavily polluting industry). Regression results show that Firm size, State ownership, State ownership, and Financial analyst coverage are significantly correlated with the probability of being a treatment firm, but the regression results of other variables are not significant. The R-squared is 37.04%. This indicates that the experimental group and the control group are not completely random and will be affected by individual characteristics. Therefore, propensity score matching is needed to solve the problem of "selection bias" in samples. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are reported in parentheses. The superscripts ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.
### Table A3.  Balance test

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<td>22.223</td>
<td>20.987</td>
<td>126.000</td>
<td>26.660</td>
</tr>
<tr>
<td></td>
<td>Matched</td>
<td>22.184</td>
<td>22.365</td>
<td>-18.400</td>
<td>-2.490</td>
</tr>
<tr>
<td><strong>EBITDA margins</strong></td>
<td>Unmatched</td>
<td>0.113</td>
<td>0.059</td>
<td>55.600</td>
<td>10.900</td>
</tr>
<tr>
<td></td>
<td>Matched</td>
<td>0.113</td>
<td>0.106</td>
<td>6.700</td>
<td>1.080</td>
</tr>
<tr>
<td><strong>Turnover rate</strong></td>
<td>Unmatched</td>
<td>6.785</td>
<td>8.364</td>
<td>-40.700</td>
<td>-7.970</td>
</tr>
<tr>
<td></td>
<td>Matched</td>
<td>6.823</td>
<td>7.010</td>
<td>-4.800</td>
<td>-0.820</td>
</tr>
<tr>
<td><strong>Return on investment</strong></td>
<td>Unmatched</td>
<td>0.736</td>
<td>0.612</td>
<td>7.900</td>
<td>1.620</td>
</tr>
<tr>
<td></td>
<td>Matched</td>
<td>0.740</td>
<td>0.690</td>
<td>3.100</td>
<td>0.520</td>
</tr>
<tr>
<td><strong>State ownership</strong></td>
<td>Unmatched</td>
<td>0.729</td>
<td>0.529</td>
<td>42.100</td>
<td>8.290</td>
</tr>
<tr>
<td></td>
<td>Matched</td>
<td>0.725</td>
<td>0.728</td>
<td>-0.800</td>
<td>-0.140</td>
</tr>
<tr>
<td><strong>Political connections</strong></td>
<td>Unmatched</td>
<td>0.330</td>
<td>0.223</td>
<td>23.900</td>
<td>4.980</td>
</tr>
<tr>
<td></td>
<td>Matched</td>
<td>0.325</td>
<td>0.355</td>
<td>-6.700</td>
<td>-1.030</td>
</tr>
<tr>
<td><strong>Financial analyst coverage</strong></td>
<td>Unmatched</td>
<td>1.968</td>
<td>0.733</td>
<td>125.500</td>
<td>26.060</td>
</tr>
<tr>
<td></td>
<td>Matched</td>
<td>1.948</td>
<td>1.945</td>
<td>0.300</td>
<td>0.050</td>
</tr>
<tr>
<td><strong>The heavily polluting industry</strong></td>
<td>Unmatched</td>
<td>0.434</td>
<td>0.355</td>
<td>16.100</td>
<td>3.290</td>
</tr>
<tr>
<td></td>
<td>Matched</td>
<td>0.436</td>
<td>0.453</td>
<td>-3.400</td>
<td>-0.550</td>
</tr>
</tbody>
</table>
This table presents statistics of matching differences in propensity score matching. Column (1) presents sample averages of firm characteristics in the treated group. Column (2) presents sample averages of firm characteristics in the control group. Column (3) presents the bias of the differences before and after being matched. Column (4) presents the t-test values of the differences between Columns (1) and (2). Column (5) presents the significance level of the sample-mean difference test between Columns (1) and (2). Results show that besides Firm size, all variables in the standard deviation are less than 10% after the match, so think the result is acceptable, illustrate the matching of the selected variables and methods is more reasonable. At the same time, the results after matching all become insignificant (in addition to Firm size is still significant, but relatively less significant compared with before matching), that, after the match, the matching variable in there is no significant difference between the experimental group and the control group, thus ensure the reliability of the PSM estimation results in this paper. Eventually, we construct a matched sample consisting of 6363 firm-year observations. Variable definitions are in Table 1. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are reported in parentheses. The superscripts ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.