# The effects of mandatory ESG disclosure on price efficiency around the world

**Abstract**

We examine the effect of mandatory environmental, social and governance (ESG) disclosure on firms' price efficiency around the world using a difference-in-differences approach. Based on data collected from public firms in 45 countries between 2000 and 2019, we find that in countries where the mandatory ESG disclosure took effect, stock price nonsynchronicity increases, suggesting that more firm-specific information has been incorporated into stock price. Furthermore, the timeliness of price discovery improves after the mandatory disclosure of ESG information, indicating the speed with which value relevant information (including ESG information) has been impounded into stock prices increases. The positive effect of ESG mandate on price nonsynchronicity and timeliness is more pronounced in countries that give priority to environment protection, in countries with low institutional quality, for firms that do not submit ESG reports, and for firms with poor corporate governance. The additional tests provide evidence that investors care about ESG disclosure, which is presented as decreased future stock returns, increased change in institutional ownership, and increased firm value.

## 1. Introduction

In recent years growing social and environmental challenges (e.g., climate change, child labor and social inequality) have prompted companies to embrace a more systematic approach towards sustainability reporting, also known as corporate social responsibility (CSR) reporting or environmental, social and governance (ESG) reporting (Ioannou and Serafeim, 2019). Furthermore, an increasing number of investors tend to make investment decisions based on not only expected returns but also non-monetary criteria and social norms (Hong and Kostovetsky, 2012). For example, socially responsible investors implement a "negative screening" approach that excludes firms operating in "sin" industries such as alcohol and tobacco, which creates additional demand for firms to disclose ESG information. Concurrent with this trend, with the support of the United Nations Environmental Program (UNEP), U.S -based Coalition for Environmentally Responsible Economies (CERES) and Tellus Institute launched the Global Reporting Initiative (GRI) in 1997 with the goal of developing and establishing rigorous and credible reporting guidelines for the "triple bottom line": accounting, environmental and social performance by corporations. GRI aimed at gradually evolving sustainability reporting to a point that it would be at par with financial reporting in terms of credibility and comparability. The Sustainability Accounting Standard Board (SASB), a non-profit organization with a focus on investors demand of non-financial information, was founded in 2012 to develop and disseminate industry-specific sustainability reporting standard and encourage companies to disclose financially material sustainability issues in compliance with the Security and Exchange Commission (SEC) requirement in the U.S.

ESG includes a wide range of environmental, social and governance issues and firms pursuing ESG agenda endeavor to meet the expectation of various stakeholders rather than

focusing only on its market value (Bénabou and Tirole, 2010). ESG information can be valuable for investors in estimating future cash flows or when evaluating firms' potential risk because ESG issues are associated with firms' business operation (Grewal et al., 2019). Although the literature documents that voluntary ESG disclosure can generate favorable capital-market consequences such as improved liquidity, lower cost of capital or higher market value (e.g., Dhaliwal et al., 2011, 2012; Lins et al., 2017), a major concern is that ESG information is voluntarily provided by firms only when it is favorable (selective disclosure). Therefore in this study we turn our attention to the mandates of ESG disclosure and its economic consequence around the world.

Since the later 1990s a growing number of countries have implemented ESG disclosure mandates, either through laws and regulations or through stock exchange listing requirements.    Mandated ESG disclosure forces firms to release previously unavailable information because firms might intentionally withhold important information in the absence of such regulation. Furthermore, firms are likely to provide more precise and reliable forward-looking information. Hence, we predict that mandatory ESG disclosure is associated with more firm-specific information being released to the market, leading to a greater proportion of individual stock price movement being explained by firm-specific ESG information.

Another benefit of mandatory ESG disclosure regulation is information transparency and comparability, because standardizing firms' ESG disclosure decreases the cost of stakeholders to obtain, process and compare ESG information. Given that the mandatory ESG disclosure enables market participants to access an expanded set of forward-looking information at a lower cost, we expect the speed with which ESG information has been incorporated into stock price to increase after the mandates took effect. The overall effect of the ESG mandates is improved stock price efficiency.

Our first measure of price efficiency is stock price nonsynchronicity (*PSI*), defined as the proportion of variation in firm-level stock return that cannot be explained by market and industry returns (Piotroski and Roulstone, 2004; Crawford et al., 2012). Following Roll (1988), we measure stock price nonsynchronicity with adjusted   from the market model regression to capture the extent to which stock price movement cannot be explained by both market and industry-wide information. This measure and its variation have been widely used in previous research (i.e., Fernandes and Ferreira, 2008; Gul et al., 2011). After a log-transformation, a high nonsynchronicity measure implies that market and industry returns can explain a smaller proportion of individual stock returns, suggesting that more firm-specific information has been impounded into stock price.

Our second measure of price efficiency is the intra-year timeliness of price discovery (*TIMELINESS*). To measure the price timeliness, we use the metric developed in Beekes et al. (2016). The metric is built on prior work (e.g., Ball and Brown, 1968; Alford et al., 1993; Beekes and Brown, 2006). The Beekes et al. measure captures the timely manner of forward-looking information to be incorporated into stock price throughout a fiscal year. Greater values of *TIMELINESS* suggest that value-relevant information is slower in coming to the market.

Using data collected from 45 countries between 2000 and 2019, we find that in countries where the mandatory ESG disclosure became effective, stock price nonsynchronicity increases, suggesting that more firm-specific information (including ESG information) has been incorporated into stock price. Furthermore, the timeliness of price discovery improves after the mandatory disclosure of ESG information, indicating the speed with which value-relevant information (including ESG information) has been impounded into stock prices increases.

We further identify the potential channels through which ESG mandate could impact stock price non-synchronicity and timeliness. We find that the positive effect of ESG mandate on price efficiency is more pronounced in countries that give priority to environment protection (where people indicate in the multiple waves of World Value Survey (WVS) that environmental protection should be given priority over economic growth). The benefit of mandatory ESG disclosure is more significant in countries with lower institutional quality, for firms that do not regularly release ESG information, and for firms with poorer corporate governance. It is likely that, before the mandate took effect, firms were under less internal and external pressure to provide ESG information, which implies that mandated ESG information generates the most capital market benefits where it is most needed. Our findings are robust to alternative mandate effective window, exclusion of observations from the U.S (representing more than 30% of the entire sample), placebo tests using pseudo effective years of mandates, and exclusion of ESG sensitive industries.

Our study makes important contribution to the literature. In recent years the business community has contemplated the broad purpose of modern corporation. Both scholars such as Nobel Laureate in Economics Oliver Hart and practitioners such as CEO and chairman of BlackRock, the largest asset management firm in the world, Larry Fink argue that the purpose of corporation goes beyond shareholder value maximization to providing products and solving social problems such as climate change and social inequality. ESG disclosure mandates enable a wide range of audience to understand the implication of firms' activities and policies on social welfare. Our study contributes to the international business research by being the first to identify the capital market consequence of mandatary ESG disclosure on stock price efficiency in terms of price nonsynchronicity and timeliness. A concurrent study by Krueger et al. (2021) explores the effect of mandatory ESG disclosure on firms' information environment. They find that mandatory ESG disclosure increases the accuracy of

analysts' earnings forecasts, lowers analyst forecast dispersion, reduces negative ESG incidents, and lowers the likelihood of stock price crashes. Our research question is fundamentally different from Krueger et al. (2021), in that we are interested in whether ESG mandates facilitate the disclosure of firm-specific information to the market, thus enhancing overall stock price efficiency.

Our study also responds to the call by Christensen et al. (2021) for more research on whether mandated non-financial reporting generates market-wide benefits and costs. It might be tempting to extrapolate findings from prior research in mandatory financial reporting to predict the consequence of mandated ESG reporting. However, the users, diversity of topic and time horizon of ESG reporting could be different from those of financial reporting. For example, the potential user of ESG reporting, which includes investors, suppliers, employees, social activists and other stakeholders, is much broader than that of financial reporting (which primarily consists of investors). In addition, ESG reporting, which encompasses a diversity of topics, policies and activities, is multi-dimensional in nature (Amel-Zadeh and Serafeim, 2018). Finally, ESG reporting generally deals with strategic activities with a long-term horizon (Bénabou and Tirole, 2010). Consequently, we encourage more scholarly investment to be directed to this area with promising research potential.

The remainder of the paper is organized as follows. Section 2 reviews the literature and develops the main hypotheses. Sample and research design are described in Section 3. Section 4 presents the results of baseline models, robustness tests, heterogeneous treatment effects, and additional tests. The final section concludes.

## 2. Related literature and hypothesis development

Although a large volume of literature has reported the economic consequence of (voluntary) CSR disclosure in terms of higher stock liquidity, lower cost of capital and better investment efficiency (see Christensen et al., 2021 for a comprehensive review), studies investigating the impact of mandatory ESG disclosure are still emerging. Ioannou and Serafeim (2019), who compare firms from four countries with CSR disclosure mandates before 2011 (China, Denmark, Malaysia and South Africa), find that firms in countries with the mandates increase the volume and quality of CSR disclosure in the post-mandate period, and are more likely to seek assurance for their disclosure. Chen et al. (2018) exploit the CSR disclosure mandate issued by Shanghai and Shenzhen Stock Exchanges in China which took effect for fiscal year ending on or after 31$^{st}$ December 2008. They find a decrease in overall industrial wastewater and $CO_2$ emissions in cities with more regulated firms. They further document that firms subject to the mandate experiences deterioration in profitability. Grewal et al. (2019) focus on short-window returns to events leading to the passage of EU directive mandating the disclosure of non-financial CSR information (EU Corporate Social Responsibility Directive: NFRD 2014/95/EU). They show on average a negative market reaction but positive returns for firms with more CSR disclosure and better CSR performance before the mandate came into force. Christensen et al. (2017) examine the real effect of the mine-safety disclosure required by the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010 in the U.S, and find that the safety of coal mines improves but productivity declines. Downar et al. (2021) investigate whether a mandate of Greenhouse gas (GHG) emissions introduced by the U.K government generates pressure for firms to decrease their emissions. They show that firms affected by the mandate reduce their emissions by about 8%, which is accompanied with a significant increase in production cost. Finally, Fiechter et al. (2022) also examine the EU Corporate Social Responsibility Directive (NFRD

2014/95/EU) that requires qualified firms to disclose non-financial information from fiscal year 2017. The report that firms increase their CSR activities and they do so even before the mandate took effect. However, a caveat of many of the prior studies is that they tend to concentrate on specific disclosure items (e.g., mine safety records or Greenhouse gas emission) in a single country. In contrast, our study looks at mandates of ESG disclosure in different countries around the world, which likely leads to enhanced power of test.

ESG disclosure could play a crucial role in mitigating the information asymmetry between corporate insiders and external stakeholders (Verrecchia, 2001). Furthermore, ESG information attracts the attention of investors, leading to more risk sharing (Merton, 1987). ESG disclosure enables more effective monitoring of managers by financial intermediaries such as analysts, which contributes to better managerial decision-making (Bushman and Smith, 2001). Finally, ESG disclosure might have spillover effect, because it provides information about other firms in the same industry (e.g., industry best practices), which results in significant capital market benefits. However, the voluntary nature of ESG disclosure raises the concern that ESG information is provided only when it is favorable. Consistent with the presence of selection bias, studies on voluntary ESG disclosure generally present beneficial effects, which is less likely to represent the entire population of firms. In the absence of mandatory ESG disclosure, firms might withhold important information. For example, using ESG disclosure data disclosed in Bloomberg, Grewal and Serafeim (2020) report that on average U.S listed firms provide only 18% of the prescribed Sustainability Accounting Standard Board (SASB) disclosure items (which serve as benchmark for financially material ESG information).

A number of countries have introduced ESG disclosure mandates in their jurisdiction. A well enforced ESG disclosure mandate could not only force firms to release previously unavailable information, but also make ESG information more precise, reliable and less

costly to collect and process. To the extent that mandatory ESG disclosure improves the information available to the market, we predict that mandatory ESG disclosure is associated with more firm-specific information being released to the market, leading to higher stock price nonsynchronicity.

One key benefit of mandatory disclosure regulation is transparency and comparability arising from standardization, because standardizing firms' ESG disclosure makes it easier for stakeholders to obtain, process and compare ESG information (Christensen et al., 2021). In other words, mandatory disclosure serves as a commitment mechanism to force firms to release relevant information regardless of their disclosure incentives and the nature of the disclosure (favorable or unfavorable information). Given that the mandatory ESG disclosure enables market participants to access an expanded information set at a lower cost, we expect the speed with which value relevant information (including ESG information) has been incorporated into stock price to increase, leading to a higher level of stock price timeliness. Based on the above discussion, we propose H1a and H1b as follows:

**H1a**: Mandatory ESG disclosure is associated with higher stock price nonsynchronicity.

**H1b**: Mandatory ESG disclosure is associated with greater stock price timeliness.

There could be arguments against H1a and H1b, however. First, mandatory ESG disclosure usually contains a "comply-or-explain" clause which provides firms with an option not to increase ESG disclosure. Instead, they need to explain why they choose not to disclose ESG information. Second, some firms already released ESG information before ESG mandate took effect, so they may continue at the same level of disclosure if the pre-existing disclosure is adequate to satisfy the regulatory requirements. These arguments suggest that

there could be no significant association between mandatory ESG disclosure and price nonsynchronicity or price timeliness. Hence, we consider the effect of mandatory ESG disclosure on firms' price informativeness and timeliness as an empirical question that warrants investigation.

## 3. Research methods

### 3.1. Sample and data

Our sample includes public firms from 45 countries for the period 2000-2019.[1] To reduce survivorship bias, we include companies delisted during the sample period. We exclude firms with missing data in dependent or explanatory variables during the sample period. We also exclude firms in financial sectors with the standard industrial classification (SIC) codes 6011-6799. Because mandatory ESG disclosure policy is likely to be simultaneous with other institutional reforms, we restrict our sample period of treatment group (i.e., countries with the implementation of mandatory ESG disclosure) to three years before and including the policy effective year, and three years after the policy effective year. This [-3, +3] sample results in a final sample of 77,580 firm-year observations for the price nonsynchronicity sample, and 78,545 firm-year observations for the price timeliness sample. Table 1 reports the sample distribution by country. As shown in the table, China has the largest number of observations in the treatment group with ESG disclosure reforms (3,129 and 3,150), and United States has the largest number of observations in the control group without ESG disclosure reforms (26,595 and 27,056). United States also contribute more than 30% of observations for the full samples.

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[1] The sample countries are developed and emerging markets defined by the MSCI World Index and the MSCI Emerging Markets Index.

[Insert Table 1 about here]

We obtain share price and financial data of public firms from Refinitiv Datastream and Refinitiv Worldscope. The effective years of mandatory ESG disclosure reform are collected from the study of Krueger et al. (2021). Major corporate governance reform years are collected from the study of Fauver et al. (2017) and documents of local stock exchanges. Firm-level corporate governance data is from Refinitiv Datastream. Institutional ownership data is from Refinitiv Ownership Database. Data with respect to the attitudes on environment protection in a country is collected from the World Values Survey. The status of ESG reporting is collected from Refinitiv ESG Database. Data for institutional quality measures and other country-level financial and macroeconomic variables is from the World Bank.

*3.2. Measuring price informativeness and price timeliness*

Following Morck et al. (2000) and Bennett et al. (2020), we construct the stock price nonsynchronicity measure based on the proportion of return variation that cannot be explained by the market and sector return where the firm resides. For each firm $i$ and year $y$ in our sample, we run following time-series regression:

$$r_{i,y,t} = \beta_{0,i,y} + \beta_{1,i,y}\, r_{m,y,t} + \beta_{2,i}\, r_{n,y,t} + \varepsilon_{i,y,t}, \tag{1}$$

where $r_{i,y,t}$ denotes the daily return time-series of firm $i$ in year $y$, $r_{m,y,t}$ and $r_{n,y,t}$ are the day $t$ value weighted return indices of the country and sector the firm $i$ operates in. In the empirical analysis, the market index is constructed using value-weighted average return of all

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the constituent firms within a market. Similarly, we construct sector indices by value-weighted average return of all firms in a sector specified by two-digit standard industry classification code (SIC).

This bi-index model leads to a natural decomposition of the stock return variation, a systematic part that is synchronous to other firms, and a firm-specific part that is informative about the firm itself. We use the log transformed $R_{i,y}^2$ adjusted for degree of freedom to capture the informativeness of the stock for the firm:

$$PSI_{i,y} = \ln\left(\frac{1 - R_{i,y}^2}{R_{i,y}^2}\right) \tag{2}$$

$$R_{i,y}^2 = 1 - \frac{T_{i,y} - 1}{T_{i,y} - k_{i,y} - 1} \frac{s^2(\varepsilon_{i,y})}{s^2(r_{i,y})} \tag{3}$$

where $T_{i,y}$ and $k_{i,y}$ are the number of daily return observations and number of explanatory variables in the index model respectively, and $s(x_{i,y})$ denote the sample standard deviation of x for firm $i$ in year $y$. A firm has large *PSI* when its stock price moves less synchronously with the market and sector index, and therefore contains larger idiosyncratic component, and more firm-specific information.

To measure the timeliness of price discovery, we use the measure based on Beekes et al. (2016). The measure is based on the assumption that most of the contents in annual earnings report are captured by the market before earnings release day (Ball and Brown, 1968). For each fiscal year, the measure traces the share price over 365 calendar days ending 14 days after the firm's annual earnings announcement day, which is an important event and is common to all firms in all countries. The measure captures the speed with which

information is reflected in stock price up to the day of the annual earnings announcement. Specifically, the timeliness of price discovery (*TIMELINESS*) is calculated as:

$$TIMELINESS = \left( \left( \sum_{t=-365}^{t=-1} |ln(P_0) - ln(P_t)| \right) - 0.5 \right) / 365 \qquad (4)$$

where $P_t$ is the daily market-adjusted stock price of a firm from 365 calendar days before the annual earnings announcement day until 1 day before the annual earnings announcement day. $P_0$ is the price 14 days after the annual earnings announcement day, which reflects the intrinsic value of the year. In order to reduce the impact of idiosyncratic volatility of price, we then deflate the measure by one plus the absolute rate of return on the share over the time window used to calculate the timeliness metric. We forward-fill prices on days when there is trading. We set the ending date to be 14 days after the earnings release date, which allows the market to gradually absorb information (Beaver, 1968). The 0.5 adjustment is included to recognize that the flow of information is reflected in returns over the day (Beekes et al. 2016). The larger the value of *TIMELINESS*, the longer it takes a firm's share price to capture information and converge to $P_0$, suggesting slower price timeliness.

*3.3. Control variables*

According to the prior research, our regression models control for other country-level and firm-level variables to explain market efficiency (e.g., Bennett et al., 2020; Bolton and Kacperczyk, 2021; Kacperczyk et al., 2021). We control the following country-level variables: *CO2*, the natural logarithm of $CO_2$ emissions in metric tons per capita; *CGRF*, a dummy variable that equals to one if a country-year is after the year when a major corporate governance reform becomes effective, and zero otherwise. We obtain the information on

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corporate governance reforms from the study by Fauver et al. (2017) and local stock exchange regulators;[2] *GQI*, the sum of three World Governance Indicators (government effectiveness, regulatory quality, and the rule of law), and the anti-self-dealing index from Djankov et al. (2008). The WGI and anti-self-dealing indices are rescaled to be between 0 and 1; *MKTCAP*, market capitalization of listed domestic companies divided by GDP; *GDPG*, annual percentage growth rate of GDP. We control the following firm-level variables: *SIZE*, the natural logarithm of total assets of a firm in U.S. dollars; *IO*, number of shares held by institutional investors divided by total number of shares outstanding; *PROFIT*, earnings before interest, taxes and depreciation divided by total assets; LEV, Total debt divided by total assets; *BM*, book value of equity divided by market value of equity; *CASH*, cash and short-term investments divided by total assets; *CAPEX*, capital expenditures divided by total assets; *TURN*, share trading volume divided by adjusted shares outstanding; *NUMEST*, the natural logarithm of number of analysts following a firm in a year; *VOLTY*, the standard deviation of daily stock returns over the 365 calendar days prior to fiscal year end date. Detailed definitions of all variables and data resources are provided in Appendix A.

Table 2 provides descriptive statistics for variables used in main tests. All time varying variables are winsorised at the top and bottom 1% to control for outliers. We only report the statistics of variables used in our baseline models and the statistics of explanatory variables are based on the price nonsynchronicity (*PSI*) model. Price nonsynchronicity (*PSI*) ranges from -1.774 to 6.018, with a mean and median of 1.500 and 1.300, and a standard deviation of 1.458. Price timeliness (*TIMELINESS*) ranges from 0.029 to 0.402, with a mean and median of 0.133 and 0.115, and a standard deviation of 0.078. The main explanatory variable of interest, *POST*, is an indicator variable that is equal to one for all subsequent years after the mandatory ESG disclosure policy becomes effective in a country, and zero otherwise.

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[2] We consult documents released by local stock exchange regulators for New Zealand, Qatar, Russia and South Africa. We identify the major board reforms and the year in which they were adopted.

*POST* has 9,999 observations with value of one, about 13% of all observations (77,580) in the *PSI* model. Table 3 provides the Pearson correlation coefficients of the main variables. The correlation between *PSI* and *POST* is 0.02, suggesting that price informativeness improves after the implementation of the mandatory ESG disclosure reform. The correlation between *TIMELINESS* and *POST* is -0.02, suggesting that price timeliness improves after the implementation of the ESG disclosure reform. In the following sections, we test our hypotheses using multivariate regressions controlling for other variables that could affect market efficiency.

[Insert Table 2 & Table 3 about here]

**4. Regression results**

We begin our regression analysis by estimating the baseline model that examine the effects of mandatory ESG disclosure on *PSI* and *TIMELINESS* respectively. Robustness of the main results is then checked. We next explore the heterogeneous treatment effects based on important country and firm characteristics. Finally, we confirm the impact of ESG disclosure on market reaction by looking at cross-sectional patterns of stock returns, institutional ownership and firm value.

*4.1. The effects of mandatory ESG disclosure on price informativeness and timeliness*

We first estimate the baseline regression models shown in Eq. (5). The dependent variables are price nonsynchronicity (*PSI*) and price timeliness (*TIMELINESS*) respectively. The main independent variable of interest is the implementation of mandatory ESG

disclosure policy (*POST*). Among the 45 sample countries, 27 countries launch ESG disclosure reforms in different years during the sample period, and 18 countries do not make such a change. This is a difference-in-differences design in multiple treatment groups and multiple time periods (Imbens and Wooldridge, 2009). Our DID approach compares changes in market efficiency after the disclosure reforms with changes in market efficiency of countries without disclosure reforms during the sample years. The approach is commonly used in the literature (Bertrand and Mullainathan, 2003; Fauver et al., 2017; Gao and Zhang, 2017). The baseline model specification is shown as follows:

$$PSI_{i,t} \ or \ TIMELINESS_{i,t} = \alpha + \beta_1(POST) + \sum \beta_m \ CONTROLS + FIRM \ FE$$
$$+ YEAR \ FE + \ \varepsilon_{i,t} \tag{5}$$

where *i* and *t* stand for firm and year respectively. *POST* is an indicator variable equal to one starting the first year and subsequent years after the mandatory ESG disclosure policy became effective in the country, and zero otherwise. *CONTROLS* includes firm- and country-level control variables. *FE* stands for firm and year fixed effects. Based on Hypothesis 1a, we expect ESG disclosure to be associated with more firm-specific information incorporated into stock prices, and thus we expect $\beta_1$ to be positive in the *PSI* baseline model. Based on Hypothesis 1b, we expect ESG disclosure to be associated with faster speed with which value relevant information is incorporated into share prices, and thus we expect $\beta_1$ to be negative in the *TIMELINESS* baseline model. In all regression estimations, we use robust standard errors clustered at the country level because the ESG disclosure policy is a country-level decision.

Columns 1 & 4 of Table 4 present the results of baseline models. The coefficient on *POST* is significantly positive in the *PSI* model ($\beta_1$=0.130, p<0.01), and significantly negative in the *TIMELINESS* model ($\beta_1$=-0.008, p<0.01). The results suggest that that stock

price informativeness and timeliness increase following the ESG disclosure reforms. Our hypotheses H1a and H1b are therefore supported. The effects are also economically significant. Column 1 shows that price informativeness increases by 8.7% relative to the mean following the reforms.[3] Column 4 shows that price timeliness increases by 6.02% relative to the mean following the reforms.[4] Columns 2 & 5 estimate the baseline models after including an interaction term between *POST* and comply-or-explain approach (*COE*). Columns 3 & 6 estimate the baseline models after including an interaction term between *POST* and all-at-once approach (*ATO*). Columns 2 shows that the coefficient on *POST*×*COE* is insignificant, suggesting that the effect of reforms on *PSI* is similar across comply-or-explain disclosure approach and stricter ESG disclosure mandates. Columns 3 shows that the coefficient on *POST*×*ATO* is insignificant, suggesting that the effect of reforms on *PSI* is similar across the countries with the introduction of mandatory environmental, social, and governance disclosure all at once and countries with gradual implementation of mandatory disclosure. Columns 5 shows that the coefficient on *POST*×*COE* is significantly positive, suggesting that the effect of reforms on *TIMELINESS* is less pronounced for countries that adopt comply-or-explain disclosure approach. Columns 6 shows that the coefficient on *POST*×*ATO* is significantly negative, suggesting that the effect of reforms on *TIMELINESS* is more pronounced for countries that introduce mandatory environmental, social, and governance disclosure all at once.


[Insert Table 4 about here]

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[3] The magnitude of impact of *POST* on *PSI* is calculated as 0.130 (coefficient on *POST* in column 1 of Table 4) ÷ 1.500 (the sample mean of *PSI* in Table 2) = 8.7%.
[4] The magnitude of impact of *POST* on *TIMELINESS* is calculated as 0.008 (absolute value of coefficient on *POST* in column 4 of Table 4) ÷ 0.133 (the sample mean of *TIMELINESS* in Table 2) = 6.02%.

With respect to control variables, stock price informativeness and timeliness are significantly related to institutional quality (*GQI*), GDP growth (*GDPG*), firm size (*SIZE*), profitability (*PROFIT*), financial leverage (*LEV*), boot-to-market ratio (*BM*), cash holding (*CASH*), and capital expenditure (*CAPEX*). The findings are generally consistent with previously documented evidence (Beekes et al., 2016; Bennett et al., 2020).

*4.2. Robustness checks*

Table 5 presents robustness checks of the findings from the baseline regression models. Panel A of Table 5 shows the results using a [-5, +5] sample and a restricted [-3, +3] that requires a firm to appear at least one year in the pre-reform period and one year in the post-reform period. The results of using the two alternative samples are similar to those reported in columns 1 & 4 of Table 4.

Panel B of Table 5 presents a policy timing analysis and regression results without US firms. In columns 1 & 2 of Panel B, *POST* is replaced by three reform timing indicator variables: *Pre-ESG disclosure years*, which equals to one for the two years before the policy effective year; *First effective year*, which equals to one for the first year after the policy effective year; and *Year 2+*, which equals one for the second and third years after the reform becomes effective, and zero otherwise. To confirm the impact of ESG disclosure reform, we expect insignificant effects of *Pre-ESG disclosure years*, and significant effects of post-reform indicator variables. For both *PSI* and *TIMELINESS* models, the results show insignificant coefficients on the *Pre-ESG disclosure years* indicator variable, and significant coefficients on the *First effective year* indicator variable. The coefficient on *Year 2+* indicator variable is significantly positive in the *PSI* model. These results suggest that the improvement in price efficiency materializes after the ESG disclosure reform becomes effective. It is likely

that our results are driven by the US firms which are over 30% percent of our sample. We therefore reestimate the baseline models based on samples without US firms. Columns 3 & 4 of Panel B show that our results remain unchanged.

[Insert Table 5 about here]

Panel C of Table 5 presents the results of placebo tests, which verify the parallel trend assumption underlying our DID estimation. Specifically, we aim to show that, in the absence of the ESG disclosure reforms, the average change in price informativeness and timeliness would have been the same for the treatment and benchmark groups. In the first placebo test, we set the pseudo effective year as three years before the actual reform effective year. In the second placebo test, we set the pseudo effective year as three years after the actual reform effective year. Panel C shows that the coefficients on *POST* are not significant for all models, suggesting that in the absence of treatment, our treatment and benchmark samples exhibit a similar trend in price efficiency.

Bolton and Kacperczyk (2021) indicate that only a few salient industries produce the most fraction of carbon emissions. There might be designated regulations or by-laws in place for the salient industries before the ESG disclosure policy is implemented. It is therefore likely that the existence of salient industries in our samples prevents us from analyzing marginal effects of the new policy on an average firm. Panel D of Table 5 presents the analysis excluding salient industries. The salient industries we define are mining (SIC>=1000 and SIC<=1499), oil & gas (SIC >=1311 and SIC<=1389), chemicals (SIC>=2800 and SIC<=2890), and utilities and transportation (SIC >= 4000 and SIC <= 4999). Regarding the effects of the ESG disclosure reform on informativeness and timeliness, our previous conclusions are unchanged.

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*4.3. Heterogeneous treatment effects*

To provide further evidence that the mandatory ESG disclosure reforms indeed cause the change in market efficiency, we create interaction terms to examine the heterogeneous treatment effects. Examining heterogeneous treatment effects using interaction terms can help to alleviate the endogeneity concerns due to omitted explanatory variables. It is less likely to have an omitted control variable correlated with the interaction term than with linear terms (Claessens and Laeven, 2003; Raddatz, 2006; Gao and Zhang, 2017). Moreover, tests of heterogeneous effects provide further managerial and policy implications. We design four sets of tests to explore the cross-sectional patterns in market efficiency with a potential causal effect of the ESG disclosure policies.

First, if the improved efficiency after the reforms is partially due to increased voluntary disclosure of ESG information, the treatment effect should be stronger in countries in which people give priority to environmental protection over economic growth. Moreover, it is more likely to see the introduction of ESG disclosure reforms in a country that prioritizes environmental issues. We obtain the information on attitudes on environment protection from the World Value Survey (WVS) database. We select four waves of the WVS covering the period from 1999 to 2020. We create an indicator variable, *Environment first*, that takes the value of one for the countries where more people agree that environment protection should be given priority over economic growth, and zero otherwise. *Environment first* is estimated based on responses to the WVS questions: "Which of them comes closer to your own point of view? 1. Protecting the environment should be given priority, even if it causes slower economic growth and some loss of jobs. 2. Economic growth and creating jobs should be the top priority, even if the environment suffers to some extent." We recode the response to this

question to one if a survey participant chose statement 1, and zero otherwise. We then calculate the mean score of responses for each country-wave. Within a wave, the score is calculated once and applies to all country-years covered by the wave. An average score is finally calculated for each country across the waves of WVS. Higher scores suggest that more people put environment protection ahead of economic growth. We create an indicator variable, *Environment first*, that takes the value of one if the attitude score is above the sample median, and zero otherwise. We reestimate Eq. (5) by replacing the *POST* indicator with *POST × Environment first* and *POST × Not environment first*. The *Not environment first* indicator is defined as (1 - *Environment first*). Panel A of Table 6 presents the results. The coefficients on *POST × Environment first* are significant at the 1% or 5% level, whereas the coefficients on *POST × Not environment first* are only significant at 10% level. The result indicates that the effect of ESG disclosure reform is more pronounced in countries where the value of environment first prevails.


[Insert Table 6 about here]


Second, the effects of ESG disclosure reform may depend on firms' status of ESG reporting. If a firm does not produce and/or submit ESG-related reports, the impact of mandatory ESG disclosure should be more pronounced for the firm. We create an indicator variable, *ESG reporting firms*, that takes the value of one if a firm has ESG reports uploaded in the Refinitiv ESG database (formerly known as ASSET4) in a year, and zero otherwise. In regression estimation, we replace the *POST* indicator with *POST × ESG reporting firms* and *POST × Non-ESG reporting firms*. The *Non-ESG reporting firms* indicator is defined as (1 - *ESG reporting firms*). Panel B of Table 6 presents the results. The coefficients on *POST × Non-ESG reporting firms* are significant at the 1% level for both *PSI* and *TIMELINESS*

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models. The coefficient on *POST × ESG reporting firms* is significant at the 10% level for the *PSI* model. The result indicates that the effect of ESG disclosure reform is more pronounced for firms without mandates to release their ESG information.

Third, prior research documents that good corporate governance improves disclosure and price efficiency (Beekes & Brown, 2006; Beekes et al., 2016; Kacperczyk et al., 2021). The mandatory ESG disclosure reforms are likely to play a governance role if firms lack sound internal governance. To test the conjecture, we create an indicator variable, *High corporate governance quality*, that takes the value of one for the firms whose average corporate governance score is above the sample median, and zero otherwise. We adopt the approach of Chung et al. (2010) and construct a firm-level index of corporate governance quality (*CGQ*) with 22 underlying governance characteristics. Appendix B gives details of governance items and criteria. If a firm meets a characteristic successfully in a given year, it will score one point and zero otherwise.[5] We weight all characteristics equally to obtain total *CGQ* index for a year. Average CGQ index is then calculated to represent the overall corporate governance quality of a firm during the sample period. In regression estimation, we replace the *POST* indicator with *POST × High corporate governance quality* and *POST × Low corporate governance quality*. The *Low corporate governance quality* indicator is defined as (1 - *High corporate governance quality*). Panel A of Table 7 presents the results. The coefficients on *POST × Low corporate governance quality* are significant at the 1% level for both *PSI* and *TIMELINESS* models. The coefficient on *POST × High corporate governance quality* is significant at the 5% level for the *TIMELINESS* model. The result shows that the effect of ESG disclosure reform is more pronounced for firms with poorer corporate governance, suggesting that ESG reform substitutes for corporate governance in enhancing price efficiency.

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[5] Due to data availability on Thomson Eikon, we collect information on corporate governance for the period of 2009 to 2017.

Lastly, considering that country-level legal institution influence investor protection, corporate governance and firm value (La Porta et al., 1997, 1998, 2000, 2002), the treatment effects are likely to be different across countries with different quality of legal institution. On one hand, better legal institution may help ESG disclosure reform to take effect via stronger enforcement of rules and regulations, and therefore the treatment effect is likely to be more pronounced in countries with better institutional quality. On the other hand, mandatory ESG disclosure reform may substitute for legal institutions in affecting price efficiency because the reforms can be implemented through other channels instead of completely through legal institutions. To explore the empirical question, we create an indicator variable, *High institutional quality*, that takes the value of one if the governance quality index of a country (*GQI*) is above the sample median, and zero otherwise. We reestimate the baseline models by replacing the *POST* indicator with *POST* × *High institutional quality* and *POST* × *Low institutional quality*. The *Low institutional quality* indicator is defined as (1 - *High institutional quality*). Panel B of Table 7 presents the results. The coefficients on *POST* × *Low institutional quality* are significant at the 1% level for both *PSI* and *TIMELINESS* models, whereas the coefficients on *POST* × *High institutional quality* are insignificant. The result indicates that the effect of ESG disclosure reform is more pronounced in countries where the value of environment first prevails.

*4.4. Do investors care about mandatory ESG disclosure?*

Our results of main tests shed some lights on the contemporaneous impact of the ESG disclosure policy on market efficiency. We continue to confirm if investors care about the changes due to the new policy in a longer term. Relevant theories suggest that if the ESG disclosure reforms help to reduce private information asymmetry, a lower cost of equity capital can be expected (Brown et al., 2004; Easley and O'Hara, 2004). Hence, we test the return predictability of the ESG disclosure reform. In addition to stock returns, we also examine the change in institutional ownership after the ESG disclosure reform. Previous studies have integrated relevant ESG factors into the analysis of pattern of stock returns. For example, Chava (2014) finds that firms that derive substantial revenues from the sale of coal or oil are associated with a higher implied cost of capital. Bolton and Kacperczyk (2021) find that carbon emissions of US firms are significantly positively related to the cross-sectional stock returns, suggesting that investors have demanded compensation for their exposure to carbon emission risk. The authors also find that institutional investors indeed divest from firms associated with high carbon emissions. Pedersen et al. (2021) sort stocks into quintiles based on individual ESG proxies and then form portfolios that goes long the best ESG stocks and short the worst ESG stocks. The authors find that the portfolio based on G (i.e., governance) has earned significant abnormal returns. In addition to stock returns, we examine the change in institutional ownership after the ESG disclosure reform.

We calculate annual market-adjusted stock returns using the same estimation window as that defined in the estimation of price timeliness. The change in institutional ownership is calculated as the absolute value of institutional ownership in year $t+1$ minus institutional ownership in year $t$. We estimate the following fixed-effects regression model:

$$RET_{i,t+1} \text{ or } \Delta IO_{i,t+1} = \alpha + \beta_1(POST) + \sum \beta_m \text{ } CONTROLS_{i,c,t} + FIRM \text{ } FE$$
$$+ YEAR \text{ } FE + \varepsilon_{i,t} \tag{7}$$

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where $RET_{i,t+1}$ refers to the stock return of company $i$ in year $t$+1. $\Delta IO_{i,t+1}$ is the change in institutional ownership in year $t$+1. *POST* is defined in the way as in Eq. (5). The vector of controls includes all the firm- and country-specific variables controlled in the *PSI* and *TIMELINESS* models. We price nonsynchronicity (*PSI*), price timeliness (*TIMELINESS*), and stock price momentum (*MM1*) as an additional control variable to explain stock returns and changes in institutional ownership. Firm fixed effects and year fixed effects are also included. We cluster standard errors at the country level. The coefficient of interest is $\beta_1$. For the return model, the expected sign of $\beta_1$ is negative because the ESG disclosure is likely to reduce the risk premium of information asymmetry and ultimately reduce investors' expected return and cost of equity capital. For the institutional ownership model, the expected sign of $\beta_1$ is positive meaning that investors may either increase investments in firms associated with good ESG performance or divest from firms associate with poor ESG performance after the ESG disclosure reforms become effective.

We are also interested to test if the ESG reforms will ultimately influence firm value, given the alleged effects on price efficiency and returns. Firm value is measured by Tobin's q, which is calculated as total assets minus book value of equity plus market value of equity divided by total assets. We estimate the following fixed-effects regression model:

$$TQ_{i,t} = \alpha + \beta_1(POST) + \sum \beta_m\, CONTROLS_{i,c,t} + FIRM\ FE$$
$$+ YEAR\ FE + \varepsilon_{i,t} \tag{8}$$

where $TQ_{i,t}$ refers to the Tobin's q of company $i$ in year $t$. The explanatory variables and fixed effects used are the same as defined in Eq. (7). We cluster standard errors at the country level. The coefficient of interest is $\beta_1$. The expected sign of $\beta_1$ is positive because the ESG

disclosure reform is likely to increase firm value if the reform reduces the cost of equity capital all others things being equal.

We report the regression results of the additional tests in Table 8. Columns 1 & 2 show the results for regression models as shown in Eq. (7). Columns 3 presents the results for regression model shown in Eq. (8). We find a negative and statistically significant effect of *POST* on future stock returns ($\beta_1$=-0.041, p<0.01). The result suggests that mandatory ESG disclosure contributes to the information set so that risk premiums on ESG factors are reduced after the implementation of new policies. Our finding echoes that of Bolton and Kacperczyk (2021) and Pedersen et al. (2021). The institutional ownership shows a significant change after the ESG reform ($\beta_1$=0.005, p<0.01), suggesting that institutional investors integrate ESG factors and adjust their portfolios accordingly. There is also evidence that firm value increases in the post-reform period ($\beta_1$=0.172, p<0.01).

[Insert Table 8 about here]

## 5. Conclusion

How does the market respond to the changes in related to ESG developments? This is a fundamental question for the emerging field of ESG and accounting/finance. The answer to the question carries valuable implications for corporate managers and policy makers. This paper examines the impact of mandatory ESG disclosure reforms launched around the world since early 2000s on price efficiency in a sample of 45 countries. We undertake a difference-in-differences analysis, and find robust evidence that the ESG disclosure reform has significantly improved price efficiency. Heterogeneous treatment tests reveal the conditions and channels by which the reforms take effects. The effects of the ESG reforms are stronger

for firms in countries that value the priority of environmental protection, for firms in countries of low institutional quality, for firms that do not release ESG related documents, and for firms that lack complete corporate governance mechanisms. We find that institutional investors care about the reforms and present a significant change in their stock ownership in the post-reform period. We also find that the ESG reforms significantly and negatively affect future stock returns, and significantly and positively affect Tobin's q, suggesting a lower cost of equity capital and higher firm value in the post-reform period.

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**Table 1**
Number of firm-year observations by country and effective years of mandatory ESG disclosure policies.
   Columns 1 & 2 show the number of firm-year observations by country based on the regression models as shown in Eq. (5) using the [-3, +3] sample. The effective years of mandatory ESG disclosure policies by country are outlined in column 3. Columns 4 & 5 indicate the reform approaches. The data on the effective years and reform approaches are collected from Krueger et al. (2021).

| | Number of Observations | | Mandatory ESG disclosure policy year | Comply-or-explain regulation? | All-at-once disclosure? |
|---|---|---|---|---|---|
| | *PSI* sample | *TIMELINESS* sample | | | |
| Country | (1) | (2) | (3) | (4) | (5) |
| Argentina | 47 | 47 | 2008 | No | Yes |
| Australia | 569 | 662 | 2003 | No | No |
| Austria | 162 | 163 | 2016 | No | No |
| Belgium | 797 | 804 | - | - | - |
| Brazil | 1,155 | 1,136 | - | - | - |
| Canada | 814 | 889 | 2004 | No | Yes |
| Chile | 139 | 143 | 2015 | Yes | No |
| China | 3,129 | 3,150 | 2008 | No | Yes |
| Colombia | 77 | 77 | - | - | - |
| Czech | 71 | 65 | - | - | - |
| Denmark | 737 | 740 | - | - | - |
| Egypt | 245 | 223 | - | - | - |
| Finland | 1,274 | 1,324 | - | - | - |
| France | 661 | 548 | 2001 | No | Yes |
| Germany | 1,409 | 1,450 | 2016 | Yes | Yes |
| Greece | 191 | 186 | 2006 | No | Yes |
| Hungary | 27 | 27 | 2016 | Yes | Yes |
| India | 2,562 | 2,554 | 2015 | No | No |
| Indonesia | 487 | 479 | 2012 | No | No |
| Ireland | 78 | 80 | 2016 | Yes | Yes |
| Israel | 259 | 242 | - | - | - |
| Italy | 646 | 653 | 2016 | Yes | Yes |
| Japan | 17,350 | 17,540 | - | - | - |
| Jordan | 43 | 44 | - | - | - |
| Korea | 3,972 | 3,686 | - | - | - |
| Malaysia | 913 | 950 | 2007 | Yes | No |
| Mexico | 725 | 757 | - | - | - |
| Netherlands | 287 | 285 | 2016 | Yes | No |
| New Zealand | 605 | 627 | - | - | - |
| Norway | 380 | 401 | 2013 | No | No |
| Pakistan | 67 | 67 | 2009 | No | Yes |
| Peru | 41 | 42 | 2016 | No | Yes |
| Philippines | 423 | 398 | 2011 | No | Yes |
| Poland | 454 | 491 | 2016 | No | Yes |
| Portugal | 124 | 126 | 2010 | No | No |
| Russia | 450 | 429 | - | - | - |
| Singapore | 367 | 376 | 2016 | Yes | No |
| South Africa | 407 | 416 | 2010 | Yes | Yes |
| Spain | 350 | 356 | 2012 | Yes | No |
| Sweden | 2,166 | 2,195 | - | - | - |
| Switzerland | 1,602 | 1,622 | - | - | - |
| Thailand | 2,057 | 2,075 | - | - | - |
| Turkey | 310 | 310 | 2014 | No | No |
| United Kingdom | 2,356 | 2,654 | 2013 | No | No |
| United States | 26,595 | 27,056 | - | - | - |

**Total** **77,580** **78,545**

**Table 2**

Summary Statistics.

This table reports summary statistics of variables using the [-3, +3] sample. *PSI* is the price nonsynchronicity, which is estimated by Eqs. (2) & (3). *TIMELINESS* is the price timeliness, which is calculated by Eq. (4). *POST* is an indicator variable that is equal to one for all subsequent years after the mandatory ESG disclosure policy becomes effective in a country, and zero otherwise. *CO2* is the natural logarithm of $CO_2$ emissions in metric tons per capita. *CGRF* is an indicator variable equal to one for all subsequent years after a major corporate governance reform became effective in the country, and zero otherwise. *GQI* is the governance quality index of a country, which is measured based on rule of law, regulatory quality, government effectiveness, and protection against self-dealing. *MKTCAP* is annual market capitalization of listed domestic companies divided by GDP. *GDPG* is GDP growth (annual %). *SIZE* is the natural logarithm of market capitalization of a firm in US dollars. *IO* is number of shares held by all types of institutions divided by total number of shares outstanding. *PROFIT* is earnings before interest, taxes and depreciation divided by total assets. *LEV* is total debt divided by total assets. *BM* is book value of equity divided by market capitalization. *CASH* is cash and short-term investments divided by total assets. *CAPEX* is capital expenditures divided by total assets. *TURN* is annual share trading volume divided by adjusted shares outstanding. *NUMEST* is the natural logarithm of number of analysts following a firm in a fiscal year. *VOLTY* is the standard deviation of daily stock returns over the 365 days prior to fiscal year end dates. Continuous variables are winsorised at the top and bottom 1% to control for outliers. For further details on variable measurement and data sources, see Table A1.

| Variables | Mean | Median | SD | Min | Max | p10 | p25 | p75 | p90 |
|---|---|---|---|---|---|---|---|---|---|
| *PSI* | 1.500 | 1.300 | 1.458 | -1.774 | 6.018 | -0.123 | 0.511 | 2.291 | 3.462 |
| *TIMELINESS* | 0.133 | 0.115 | 0.078 | 0.029 | 0.402 | 0.051 | 0.074 | 0.171 | 0.240 |
| *POST* | 0.129 | 0.000 | 0.335 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 | 1.000 |
| *CO2* | 2.228 | 2.250 | 0.628 | 0.432 | 3.019 | 1.344 | 1.952 | 2.745 | 2.942 |
| *CGRF* | 0.883 | 1.000 | 0.321 | 0.000 | 1.000 | 0.000 | 1.000 | 1.000 | 1.000 |
| *GQI* | 2.532 | 2.720 | 0.610 | 0.292 | 3.841 | 1.470 | 2.353 | 2.933 | 3.026 |
| *MKTCAP* | 1.007 | 1.006 | 0.415 | 0.219 | 2.232 | 0.452 | 0.665 | 1.337 | 1.502 |
| *GDPG* (%) | 2.535 | 2.244 | 2.598 | -5.693 | 10.636 | 0.042 | 1.458 | 3.160 | 6.084 |
| *SIZE* | 13.853 | 13.797 | 1.823 | 9.763 | 18.286 | 11.537 | 12.566 | 15.071 | 16.322 |
| *IO* | 0.401 | 0.291 | 0.324 | 0.003 | 1.122 | 0.049 | 0.129 | 0.681 | 0.918 |
| *PROFIT* | 0.098 | 0.109 | 0.142 | -0.647 | 0.406 | 0.005 | 0.067 | 0.160 | 0.222 |
| *LEV* | 0.224 | 0.209 | 0.179 | 0.000 | 0.701 | 0.000 | 0.060 | 0.347 | 0.474 |
| *BM* | 0.687 | 0.523 | 0.583 | 0.042 | 3.298 | 0.166 | 0.294 | 0.886 | 1.397 |
| *CASH* | 0.173 | 0.115 | 0.179 | 0.002 | 0.887 | 0.019 | 0.049 | 0.229 | 0.410 |
| *CAPEX* | 0.050 | 0.036 | 0.048 | 0.001 | 0.259 | 0.007 | 0.017 | 0.065 | 0.108 |
| *TURN* | 1.471 | 0.927 | 1.639 | 0.010 | 9.000 | 0.149 | 0.388 | 1.926 | 3.461 |
| *NUMEST* | 3.985 | 4.060 | 1.058 | 1.386 | 5.948 | 2.485 | 3.178 | 4.820 | 5.342 |
| *VOLTY* | 0.021 | 0.019 | 0.010 | 0.008 | 0.059 | 0.011 | 0.014 | 0.025 | 0.033 |

**Table 3**

Correlation Matrix.

This table reports the Pearson correlations among variables. Continuous variables are winsorised at the top and bottom 1% to control for outliers. * indicates that the correlation is significant at least at the 5% level (two-tailed test). For further details on variable measurement and data sources, see Table A1.

| | | [2] | [3] | [4] | [5] | [6] | [7] | [8] | [9] | [10] | [11] | [12] | [13] | [14] | [15] | [16] | [17] | [18] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PSI | [1] | 0.20* | 0.02* | 0.04* | -0.16* | 0.13* | 0.14* | -0.02* | -0.54* | -0.12* | -0.21* | -0.07* | 0.09* | 0.13* | -0.07* | -0.17* | -0.37* | 0.18* |
| TIMELINESS | [2] | | -0.02* | 0.04* | -0.07* | -0.01* | 0.01* | 0.05* | -0.28* | -0.02* | -0.27* | 0.01* | 0.08* | 0.18* | 0.03* | 0.20* | -0.15* | 0.55* |
| POST | [3] | | | -0.33* | 0.10* | -0.26* | -0.17* | 0.39* | -0.06* | -0.18* | 0.06* | 0.01 | -0.07* | -0.04* | 0.07* | -0.06* | -0.03* | -0.06* |
| CO2 | [4] | | | | -0.16* | 0.71* | 0.43* | -0.32* | 0.06* | 0.52* | -0.13* | -0.05* | -0.06* | 0.10* | -0.04* | 0.28* | 0.10* | 0.15* |
| CGRF | [5] | | | | | -0.10* | 0.06* | -0.41* | -0.01 | 0.47* | -0.11* | -0.08* | -0.09* | 0.07* | -0.11* | 0.06* | 0.12* | 0.04* |
| GQI | [6] | | | | | | 0.55* | -0.41* | -0.01 | 0.47* | -0.11* | -0.08* | -0.09* | 0.07* | -0.11* | 0.06* | 0.12* | 0.04* |
| MKTCAP | [7] | | | | | | | -0.03* | 0.02* | 0.51* | -0.08* | -0.04* | -0.23* | 0.09* | -0.05* | 0.17* | 0.15* | -0.02* |
| GDPG | [8] | | | | | | | | -0.10* | -0.15* | 0.08* | 0.03* | -0.17* | -0.02* | 0.14* | 0.11* | -0.03* | -0.06* |
| SIZE | [9] | | | | | | | | | 0.23* | 0.21* | 0.33* | 0.04* | -0.36* | 0.04* | 0.03* | 0.63* | -0.39* |
| IO | [10] | | | | | | | | | | 0.01 | 0.02* | -0.24* | 0.01* | -0.06* | 0.34* | 0.39* | -0.01 |
| PROFIT | [11] | | | | | | | | | | | -0.02* | -0.16* | -0.35* | 0.20* | -0.09* | 0.16* | -0.43* |
| LEV | [12] | | | | | | | | | | | | 0.06* | -0.42* | 0.12* | 0.03* | 0.08* | -0.04* |
| BM | [13] | | | | | | | | | | | | | -0.19* | -0.05* | -0.14* | -0.27* | 0.11* |
| CASH | [14] | | | | | | | | | | | | | | -0.20* | 0.16* | -0.08* | 0.30* |
| CAPEX | [15] | | | | | | | | | | | | | | | 0.04* | 0.07* | -0.01* |
| TURN | [16] | | | | | | | | | | | | | | | | 0.16* | 0.34* |
| NUMEST | [17] | | | | | | | | | | | | | | | | | -0.21* |
| VOLTY | [18] | | | | | | | | | | | | | | | | | |

**Table 4**

The effects of mandatory ESG disclosure on price informativeness and timeliness: Baseline results.

This table presents the regression results of the impact of mandatory ESG disclosure on price informativeness and timeliness using the [-3, +3] sample. The dependent variables are price nonsynchronicity (*PSI*) in columns 1-3, and price timeliness (*TIMELINESS*) in columns 4-6. *POST* is an indicator variable that is equal to one for all subsequent years after the mandatory ESG disclosure policy becomes effective in a country, and zero otherwise. *COE* is an indicator variable that is equal to one for all subsequent years after the mandatory ESG disclosure policy becomes effective in a country if comply-or-explain ESG disclosure approach is adopted, and zero otherwise. *ATO* is an indicator variable that is equal to one for all subsequent years after the mandatory ESG disclosure policy becomes effective in a country if mandatory environmental, social, and governance disclosure are introduced all at once, or zero if the country implements mandatory disclosure gradually. *CO2* is the natural logarithm of $CO_2$ emissions in metric tons per capita. *CGRF* is an indicator variable equal to one for all subsequent years after a major corporate governance reform became effective in the country, and zero otherwise. *QLI* is governance quality index of a country, which is measured based on rule of law, regulatory quality, government effectiveness, and protection against self-dealing. *MKTCAP* is annual market capitalization of listed domestic companies divided by GDP. *GDPG* is GDP growth (annual %). *SIZE* is the natural logarithm of market capitalization of a firm in US dollars. *IO* is number of shares held by all types of institutions divided by total number of shares outstanding. *PROFIT* is earnings before interest, taxes and depreciation divided by total sales. *LEV* is total debt divided by total assets. *BM* is book value of equity divided by market capitalization. *CASH* is cash and short-term investments divided by total assets. *CAPEX* is capital expenditures divided by total assets. *TURN* is share trading volume divided by adjusted shares outstanding. *NUMEST* is the natural logarithm of number of analysts following a firm in a fiscal year. *VOLTY* is the standard deviation of daily stock returns over the 365 days prior to fiscal year end dates. All continuous variables are winsorised at the top and bottom 1% to control for outliers. Standard errors are clustered at the country level. The t-statistics are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively (two-tailed tests). For further details on variable measurement and data sources, see Table A1.

| Dependent variable | PSI | | | TIMELINESS | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *POST* | 0.130*** | 0.104* | 0.042 | -0.008*** | -0.011*** | -0.005** |
| | (2.91) | (1.77) | (0.53) | (-2.96) | (-2.90) | (-2.51) |
| *POST × COE* | | 0.086 | | | 0.007* | |
| | | (0.73) | | | (1.94) | |
| *POST × ATO* | | | 0.193 | | | -0.009* |
| | | | (1.64) | | | (-1.82) |
| Country-level controls | | | | | | |
| *CO2* | 0.598 | 0.604 | 0.559 | 0.006 | 0.006 | 0.008 |
| | (1.46) | (1.46) | (1.41) | (0.92) | (1.03) | (1.64) |
| *CGRF* | -0.296 | -0.293 | -0.305 | 0.004* | 0.004* | 0.005** |
| | (-1.37) | (-1.38) | (-1.42) | (1.77) | (1.90) | (2.05) |
| *GQI* | -1.303*** | -1.292*** | -1.278*** | -0.019*** | -0.018*** | -0.020*** |
| | (-2.78) | (-2.68) | (-2.65) | (-5.13) | (-4.44) | (-5.80) |
| *MKTCAP* | 0.614*** | 0.609*** | 0.604*** | 0.002 | 0.001 | 0.002 |
| | (2.97) | (2.99) | (2.94) | (0.17) | (0.14) | (0.22) |
| *GDPG* | -0.053*** | -0.053*** | -0.053*** | 0.001** | 0.001** | 0.001** |
| | (-3.34) | (-3.33) | (-3.34) | (2.12) | (2.12) | (2.12) |
| Firm-level Controls | | | | | | |
| *SIZE* | -0.340*** | -0.339*** | -0.342*** | -0.005*** | -0.005*** | -0.005*** |
| | (-18.29) | (-18.93) | (-18.58) | (-5.53) | (-5.78) | (-5.84) |
| *IO* | -0.399 | -0.402 | -0.396 | 0.015*** | 0.014*** | 0.014*** |
| | (-1.56) | (-1.58) | (-1.56) | (5.45) | (5.28) | (5.37) |

| | | | | | | |
|---|---|---|---|---|---|---|
| *PROFIT* | -0.314** | -0.315** | -0313** | -0.021*** | -0.021*** | -0.021*** |
| | (-2.44) | (-2.44) | (-2.42) | (-5.51) | (-5.53) | (-5.58) |
| *LEV* | 0.802*** | 0.802*** | 0.800*** | 0.033*** | 0.033*** | 0.033*** |
| | (11.10) | (11.12) | (11.00) | (10.51) | (10.47) | (10.39) |
| *BM* | 0.324*** | 0.324*** | 0.324*** | 0.009*** | 0.009*** | 0.009*** |
| | (4.56) | (4.56) | (4.57) | (2.89) | (2.89) | (2.88) |
| *CASH* | -0.403*** | -0.403*** | -0.405*** | -0.013*** | -0.013*** | -0.013*** |
| | (-6.22) | (-6.21) | (-6.26) | (-4.82) | (-4.84) | (-4.83) |
| *CAPEX* | -0.743*** | -0.746*** | -0.759*** | 0.020** | 0.020** | 0.021** |
| | (-4.26) | (-4.25) | (-4.39) | (2.25) | (2.22) | (2.39) |
| *TURN* | -0.057** | -0.057** | -0.058** | -0.001 | -0.001 | -0.001 |
| | (-2.55) | (-2.56) | (-2.57) | (-0.79) | (-0.97) | (-0.76) |
| *NUMEST* | -0.064* | -0.064* | -0.066* | -0.001 | -0.001 | -0.001 |
| | (-1.84) | (-1.83) | (-1.85) | (-1.01) | (-0.97) | (-0.95) |
| *VOLTY* | -0.307 | -0.328 | -0.254 | 3.324*** | 3.321*** | 3.318*** |
| | (-0.06) | (-0.06) | (-0.05) | (38.74) | (39.51) | (39.52) |
| Number of observations | 77,580 | 77,580 | 77,580 | 78,545 | 78,545 | 78,545 |
| Adjusted R-squared | 0.304 | 0.304 | 0.305 | 0.170 | 0.170 | 0.170 |
| Firm fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |

**Table 5.**
The effects of mandatory ESG disclosure on price informativeness and timeliness: Robustness checks.

Panel A reports the robustness checks using two alternative samples: a [-5, +5] sample and a restrictive [-3, +3] sample that requires a firm to appear at least one year before the first effective year and one year after the effective year. Panel B presents the results using trend analysis and excluding the US firms. Panel C reports results of placebo tests using pseudo effective years. Panel D reports results excluding ESG sensitive industries. Continuous variables are winsorised at the top and bottom 1% to control for outliers. The results of control variables and fixed effects are not reported for brevity. Standard errors are clustered at the country level. The t-statistics are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively (two-tailed tests). For further details on variable measurement and data sources, see Table A1.

| Panel A: Alternative event window and restricted sample tests | | | | |
|---|---|---|---|---|
| | [-5, +5] sample | | Restricted sample | |
| Dependent variable | *PSI* | *TIMELINESS* | *PSI* | *TIMELINESS* |
| | (1) | (2) | (3) | (4) |
| *POST* | 0.117** | -0.008*** | 0.131*** | -0.008*** |
| | (2.24) | (-3.25) | (2.88) | (-3.00) |
| Number of observations | 87,071 | 88,364 | 74,356 | 75,197 |
| Adjusted R-squared | 0.284 | 0.171 | 0.308 | 0.173 |
| Control variables | Yes | Yes | Yes | Yes |
| Firm fixed effects | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes |

| Panel B: Pre- and post-reform and non-US sample tests. | | | | |
|---|---|---|---|---|
| | Pre- and post-ESG disclosure | | Excluding the U.S. firms | |
| Dependent variable | *PSI* | *TIMELINESS* | *PSI* | *TIMELINESS* |
| | (1) | (2) | (3) | (4) |
| *POST* | | | 0.143*** | -0.007** |
| | | | (3.77) | (-2.54) |
| *Pre-ESG disclosure years* | 0.106 | 0.007 | | |
| | (1.14) | (1.61) | | |
| *First effective year* | 0.177** | -0.006** | | |
| | (2.40) | (-2.25) | | |
| *Year 2+* | 0.197** | -0.004 | | |
| | (2.19) | (-1.07) | | |
| Number of observations | 77,580 | 78,545 | 50,985 | 51,489 |
| Adjusted R-squared | 0.304 | 0.170 | 0.267 | 0.141 |
| Control variables | Yes | Yes | Yes | Yes |
| Firm fixed effects | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes |

| Panel C: Placebo tests | | | | |
|---|---|---|---|---|
| | 3 years pre-reform | | 3 years post-reform | |
| Dependent variable | *PSI* | *TIMELINESS* | *PSI* | *TIMELINESS* |
| | (1) | (2) | (3) | (4) |
| *POST* | 0.006 | 0.002 | -0.078 | -0.003 |
| | (0.07) | (0.92) | (-0.76) | (-1.17) |
| Number of observations | 73,313 | 74,027 | 78,510 | 79,748 |

| | | | | |
|---|---|---|---|---|
| Adjusted R-squared | 0.313 | 0.170 | 0.300 | 0.166 |
| Control variables | Yes | Yes | Yes | Yes |
| Firm fixed effects | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes |

Panel D: Excluding ESG sensitive industries.

| Dependent variable | PSI | TIMELINESS |
|---|---|---|
| | (1) | (2) |
| POST | 0.143*** | -0.009*** |
| | (3.09) | (-3.59) |
| Number of observations | 65,300 | 66,246 |
| Adjusted R-squared | 0.305 | 0.165 |
| Control variables | Yes | Yes |
| Firm fixed effects | Yes | Yes |
| Year fixed effects | Yes | Yes |

**Table 6.**
Heterogeneous treatment effects based on attitudes on environment protection and status of ESG reporting.

   Panel A reports the results of examining the relative effects of ESG disclosure reform on market efficiency in different countries based on the attitude on the priority of environment protection. *Environment first* is an indicator variable that takes the value of one for the countries where people agree that environment protection should be given priority over economic growth, and zero otherwise. *Not environment first* is (1 - *Environment first*). Panel B reports the results of examining the relative effects of ESG disclosure reform on market efficiency for different firms based on the status of ESG reporting. *ESG reporting firms* is an indicator variable that takes the value of one if a firm has ESG reports uploaded in the Refinitiv ESG database in a year, and zero otherwise. *Non-ESG reporting firms* is (1 - *ESG reporting firms*). Continuous variables are winsorised at the top and bottom 1% to control for outliers. The results of control variables and fixed effects are not reported for brevity. Standard errors are clustered at the country level. The t-statistics are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively (two-tailed tests). For further details on variable measurement and data sources, see Table A1.

| Panel A: Heterogeneous effects based on the attitudes on environment protection | | |
|---|---|---|
| Dependent variable | *PSI* | *TIMELINESS* |
| | (1) | (2) |
| *POST* × *Environment first* | 0.131** | -0.010*** |
| | (2.15) | (-3.02) |
| *POST* × *Not environment first* | 0.128* | -0.004* |
| | (1.69) | (-1.76) |
| | | |
| Number of observations | 75,611 | 76,567 |
| Adjusted R-squared | 0.306 | 0.170 |
| Control variables | Yes | Yes |
| Firm fixed effects | Yes | Yes |
| Year fixed effects | Yes | Yes |
| Panel B: Heterogeneous effects based on the status of ESG reporting | | |
| Dependent variable | *PSI* | *TIMELINESS* |
| | (1) | (2) |
| *POST* × *ESG reporting firms* | 0.113* | -0.003 |
| | (1.73) | (-1.30) |
| *POST* × *Non-ESG reporting firms* | 0.138*** | -0.011*** |
| | (2.61) | (-3.52) |
| | | |
| Number of observations | 77,580 | 78,545 |
| Adjusted R-squared | 0.304 | 0.170 |
| Control variables | Yes | Yes |
| Firm fixed effects | Yes | Yes |
| Year fixed effects | Yes | Yes |

**Table 7.**
Heterogeneous effects based on corporate governance and institutional quality.

   Panel A reports the results of examining the relative effects of ESG disclosure reform on market efficiency for different firms based on corporate governance quality. *High corporate governance quality* is an indicator variable that takes the value of one for the firms whose average corporate governance score is above the sample median, and zero otherwise. *Low corporate governance quality* is (1 - *High corporate governance quality*). Panel B reports the results of examining the relative effects of ESG disclosure reform on market efficiency in different countries based on institutional quality. *High institutional quality* is an indicator variable that takes the value of one for the countries whose institutional quality index is above the sample median, and zero otherwise. *Low institutional quality* is (1 - *High institutional quality*). Continuous variables are winsorised at the top and bottom 1% to control for outliers. The results of control variables and fixed effects are not reported for brevity. Standard errors are clustered at the country level. The t-statistics are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively (two-tailed tests). For further details on variable measurement and data sources, see Table A1.

| Panel A: Heterogeneous effects based on corporate governance quality | | |
|---|---|---|
| Dependent variable | *PSI* | *TIMELINESS* |
| | (1) | (2) |
| *POST × High corporate governance quality* | 0.037 | -0.006** |
| | (0.55) | (-2.01) |
| *POST × Low corporate governance quality* | 0.194*** | -0.010*** |
| | (2.96) | (-3.57) |
| Number of observations | 77,580 | 78,545 |
| Adjusted R-squared | 0.304 | 0.170 |
| Control variables | Yes | Yes |
| Firm fixed effects | Yes | Yes |
| Year fixed effects | Yes | Yes |
| Panel B: Heterogeneous effects based on legal institution quality | | |
| Dependent variable | *PSI* | *TIMELINESS* |
| | (1) | (2) |
| *POST × High institutional quality* | 0.021 | -0.005 |
| | (0.23) | (-1.46) |
| *POST × Low institutional quality* | 0.174*** | -0.010*** |
| | (2.79) | (-3.09) |
| Number of observations | 77,580 | 77,852 |
| Adjusted R-squared | 0.304 | 0.167 |
| Control variables | Yes | Yes |
| Firm fixed effects | Yes | Yes |
| Year fixed effects | Yes | Yes |

**Table 8.**

The impact of mandatory ESG disclosure on stock returns.

   This table presents the regression results of the impact of mandatory ESG disclosure on stock returns and changes in institutional ownership using the [-3, +3] sample. In column 1, the dependent variable is stock return (*RET*), measured as market-adjusted annual returns of a share in year *t*+1. In column 2, the dependent variable is the change in institutional ownership (Δ*IO*), measured as the absolute value of institutional ownership in year *t*+1 minus institutional ownership in year *t*. In column 3, the dependent variable is Tobin's q (*TQ*), measured as total assets minus book value of equity plus market value of equity divided by total assets in year *t*. *RET* and Δ*IO* lead explanatory variables by one year, and *TQ* is contemporaneous with explanatory variables. *POST* is an indicator variable that is equal to one for all subsequent years after the mandatory ESG disclosure policy becomes effective in a country, and zero otherwise. *PSI* and *TIMELINESS* are price nonsynchronicity and price timeliness respectively. *MM1* stands for price momentum measured as the compounded returns over the previous 12 months. Other control variables are the same as those used in Table 4. Continuous variables are winsorised at the top and bottom 1% to control for outliers. The results of control variables and fixed effects are not reported for brevity. Standard errors are clustered at the country level. The t-statistics are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively (two-tailed tests). For further details on variable measurement and data sources, see Table A1.

| Dependent variable | RET | ΔIO | TQ |
|---|---|---|---|
| | (1) | (2) | (3) |
| POST | -0.041*** | 0.005*** | 0.172*** |
| | (-2.60) | (2.79) | (3.86) |
| Country-level controls | | | |
| CO2 | -0.072 | 0.016* | -0.198 |
| | (-1.57) | (1.66) | (-0.91) |
| CGRF | -0.024 | -0.010** | -0.113** |
| | (-1.38) | (-2.26) | (-1.99) |
| GQI | -0.052 | 0.013* | -0.553** |
| | (-1.15) | (1.91) | (-2.43) |
| MKTCAP | 0.068 | 0.007* | 0.573*** |
| | (1.33) | (1.84) | (3.58) |
| GDPG | 0.004 | 0.001** | -0.016*** |
| | (1.01) | (2.04) | (-2.69) |
| Firm-level Controls | | | |
| PSI | 0.010*** | 0.001*** | -0.081*** |
| | (2.87) | (3.85) | (-10.32) |
| TIMELINESS | 0.097 | 0.042*** | 0.101 |
| | (1.29) | (2.81) | (0.48) |
| SIZE | -0.137*** | -0.005*** | -0.299*** |
| | (-14.03) | (-2.94) | (-8.21) |
| IO | -0.054*** | 0.008 | 0.247*** |
| | (-2.94) | (0.62) | (6.09) |
| PROFIT | -0.059 | -0.002 | 1.071*** |
| | (-1.31) | (-1.36) | (4.85) |
| LEV | 0.217*** | 0.014*** | -0.507*** |
| | (9.14) | (2.82) | (-3.90) |
| BM | 0.170*** | 0.002 | -0.293*** |
| | (7.75) | (1.19) | (-5.84) |
| CASH | -0.053 | 0.001 | 0.738*** |

|  |  |  |  |
|---|---|---|---|
|  | (-1.04) | (0.14) | (8.60) |
| *CAPEX* | -0.352*** | -0.005 | 1.254*** |
|  | (-3.63) | (-0.80) | (3.77) |
| *TURN* | -0.017*** | 0.001*** | -0.007 |
|  | (-3.07) | (7.19) | (-1.16) |
| *NUMEST* | -0.044*** | -0.002* | 0.141*** |
|  | (-11.04) | (-1.91) | (4.36) |
| *VOLTY* | 2.626* | 0.380*** | 5.782*** |
|  | (1.85) | (6.63) | (2.77) |
| *MM1* | -0.053*** | 0.001 | 0.308*** |
|  | (-8.42) | (1.07) | (11.66) |
|  |  |  |  |
| Number of observations | 73,105 | 74,129 | 74,358 |
| Adjusted R-squared | 0.115 | 0.055 | 0.275 |
| Firm fixed effects | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes |

## Appendix A. Variable definitions

**Table A1**

| Variable | Acronym | Description | Data source |
|---|---|---|---|
| Stock price nonsynchronicity | *PSI* | PSI is a measure of stock price informativeness based on the $R^2$ from asset pricing regressions, as shown in Eqs. (1) – (3). | Refinitiv Datastream <br><br> Authors' own calculation |
| Stock price timeliness | *TIMELINESS* | The price timeliness of value-relevant news, based on daily market-adjusted share prices, as estimated in Eq. (4). The measure is deflated by one plus the absolute rate of return on the share over the period. | Refinitiv Datastream & Worldscope <br><br> Authors' own calculation |
| Mandatory ESG disclosure | *POST* | An indicator variable that is equal to one for all subsequent years after the mandatory ESG disclosure policy becomes effective in a country, and zero otherwise. | Krueger et al. (2021) |
| Comply-or-explain | *COE* | An indicator variable that is equal to one for all subsequent years after the mandatory ESG disclosure policy becomes effective in a country if comply-or-explain ESG disclosure approach is adopted, and zero otherwise. | Krueger et al. (2021) |
| All-at-once | *ATO* | An indicator variable that is equal to one for all subsequent years after the mandatory ESG disclosure policy becomes effective in a country if mandatory environmental, social, and governance disclosure are introduced all at once, or zero if the country implements mandatory disclosure gradually. | Krueger et al. (2021) |
| Carbon emissions | *CO2* | *CO2* is the natural logarithm of $CO_2$ emissions in metric tons per capita. | World Development Indicators |
| Corporate governance reform | *CGRF* | An indicator variable equal to one for all subsequent years after a major corporate governance reform became effective in the country, and zero otherwise. | Fauver et al. (2017) <br><br> Local stock exchanges |
| Governance quality index | *GQI* | Sum of three World Governance Indicators (government effectiveness, regulatory quality, and the rule of law), and the anti-self-dealing index from Djankov et al. (2008). The WGI and anti-self-dealing indices are rescaled to be between 0 and 1. | World Governance Indicators <br><br> Djankov et al. (2008) |

| | | | |
|---|---|---|---|
| Stock market capitalization | *MKTCAP* | Market capitalization of listed domestic companies divided by GDP. | World Development Indicators |
| GDP growth | *GDPG* | Annual percentage growth rate of GDP. | World Development Indicators |
| Environment first | *ATTUD* | Environment first score of a country is estimated based on responses to the WVS questions: "Which of them comes closer to your own point of view? 1. Protecting the environment should be given priority, even if it causes slower economic growth and some loss of jobs. 2. Economic growth and creating jobs should be the top priority, even if the environment suffers to some extent." We recode the response to this question to one if a survey participant chose statement 1, and zero otherwise. We then calculate the mean of the response for each country-wave. The score is calculated for each wave of the WVS. Within a wave, the score is calculated once and applies to all country-years covered by the wave. An average score is calculated for each country. Higher scores suggest that people put environment protection in the first place. | Four waves of the World Value Survey (WVS) in 1999-2004, 2005-2009, 2010-2014, and 2017-2020. |
| ESG reporting firms | *ESGRPT* | An indicator variable that takes the value of one if a firm has ESG reports uploaded in the Refinitiv ESG database in a year, and zero otherwise. | Refinitiv ESG Database |
| Corporate governance quality | *CGQ* | Refer to the Appendix B for our corporate governance standards relating to financial and operating, following Chung et al. (2010). CGQ is the ratio of their CG scores according to these 22 CG standards, divided by the full score of 22. | Refinitiv Eikon |
| Firm size | *SIZE* | The natural logarithm of total assets of a firm in U.S. dollars (Worldscope item 02999) | Refinitiv Worldscope |
| Institutional ownership | *IO* | Number of shares held by all types of institutions divided by total number of shares outstanding. | Refinitiv Ownership Database |
| Profitability | *PROFIT* | Earnings before interest, taxes and depreciation (Worldscope item 18198) divided by total assets (Worldscope item 02999). | Refinitiv Worldscope |

| | | | |
|---|---|---|---|
| Leverage | *LEV* | Total debt (Worldscope item 03255) divided by total assets (Worldscope item 02999). | Refinitiv Worldscope |
| Book to market ratio | *BM* | Book value of equity (Worldscope item 03501) divided by market value of equity (Worldscope item 08001). | Refinitiv Worldscope |
| Cash holding | *CASH* | Cash and short-term investments (Worldscope item 02001) divided by total assets (Worldscope item 02999). | Refinitiv Worldscope |
| Capital expenditure | *CAPEX* | Capital expenditures (Worldscope item 04601) divided by total assets (Worldscope item 02999). | Refinitiv Worldscope |
| Stock trading volume | *TURN* | Share trading volume (Datastream item VO) divided by adjusted shares outstanding (Datastream items NOSH/AF). | Refinitiv Datastream |
| Analyst following | *NUMEST* | The natural logarithm of number of analysts following a firm in a fiscal year. | I/B/E/S |
| Stock return volatility | *VOLTY* | The standard deviation of daily stock returns over the 365 calendar days prior to fiscal year end date. | Refinitiv Datastream<br><br>Authors' own calculation |
| Stock price momentum | *MM1* | Compounded stock returns over the previous 12 months. | Refinitiv Datastream<br><br>Authors' own calculation |
| Stock return | *RET* | Market-adjusted annual returns of a share in year $t+1$ | Refinitiv Datastream<br><br>Authors' own calculation |
| Change in institutional ownership | $\Delta IO$ | The absolute value of institutional ownership in year $t+1$ minus institutional ownership in year $t$. | Refinitiv Ownership Database |
| Tobin's q | *TQ* | Total assets (Worldscope item 02999) minus book value of equity (Worldscope item 03501) plus market value of equity (Worldscope item 08001) divided by total assets. | Refinitiv Worldscope |

# Appendix B. Construction of corporate governance index.

**Table B1**

This table shows the construction method for the corporate governance quality index. Following Chung et al. (2010), we adopt 22 CG standards relating to financial and operating transparency. The CG standards are taken from data compiled by Refinitiv Eikon.

| Item No. | Aspect of CG | Thomson Data Item | Our Construction |
|---|---|---|---|
| 1 | Audit | Audit committee independence | 1 if audit committee independence is true, and 0 otherwise. |
| 2 | Board | Strictly Independent Board Members | 1 if strictly independent board members are more than 50% of the board directors, and 0 otherwise. |
| 3 | Board | Nomination Committee Independence | 1 if nomination committee independence is true, and 0 otherwise. |
| 4 | Board | Compensation Committee Independence | 1 if compensation committee is compromised solely of independent outside directors, and 0 otherwise. |
| 5 | Board | Committee Meetings Attendance Average | 1 if committee meeting attendance average is >0 (i.e., meets at least once during the year), and 0 otherwise. |
| 6 | Board | Staggered Board Structure | 1 If staggered board structure is false, and 0 otherwise. |
| 7 | Board | Board Size | 1 if board Size > 5 and < 16, and 0 otherwise. |
| 8 | Board | Elimination of Cumulative Voting Rights | 1 if elimination of cumulative voting rights is false, and 0 otherwise. |
| 9 | Board | CEO Board Member | 1 if CEO serves on no more than two additional boards of other public companies, and 0 otherwise. |
| 10 | Board | Chairman is ex-CEO | 1 if chairman is not ex-CEO, and 0 otherwise. |
| 11 | Board | CEO-Chairman Separation | 1 if CEO and Chairman is separated, and 0 otherwise. |
| 12 | Board | Disclosure of Board Guidelines | 1 if any of the following policies is available publicly, and 0 otherwise. <ul><li>Board Independence</li><li>Board Diversity</li><li>Board Experience</li><li>Executive Compensation Performance</li><li>Executive Compensation ESG Performance</li><li>Executive Retention</li></ul> |
| 13 | Charter | Poison Pill | 1 if there is no poison pill provision, and 0 otherwise. |
| 14 | Charter | Supermajority Vote Requirement | 1 if Supermajority Vote Requirement is false, and 0 otherwise. |
| 15 | Charter | Shareholder Approval Significant Transactions | 1 if Shareholder Approval Significant Transactions is true, and 0 otherwise. |
| 16 | Charter | Written Consent Requirements | 1 if Written Consent Requirements is true, and 0 otherwise. |
| 17 | Charter | Limited Shareholder Rights to Call Meetings | 1 if Limited Shareholder Rights to Call Meetings is false, and 0 otherwise. |
| 18 | Charter | Unlimited Authorized Capital or Blank Check | 1 if Unlimited Authorized Capital or Blank Check is false, and 0 otherwise. |
| 19 | Compensation | Board Member Long Term Compensation Incentives | 1 if Board Member Long Term Compensation Incentives>0, and 0 otherwise. |
| 20 | Ownership | Executive Compensation Long Term Objectives | 1 if Executive Compensation Long Term Objectives is true, and 0 otherwise. |
| 21 | Ownership | Shareholders Approval Stock Compensation Plan | 1 if Shareholders Approval Stock Compensation Plan is true, and 0 otherwise. |
| 22 | Anti-Takeover Devices | Anti-Takeover Devices | 1 if there is no anti-takeover device, and 0 otherwise. |