The impact of CSR reporting mandate on CSR graph disclosure quality: Evidence from the European Union's CSR Directive

Abstract

We investigate the impact of the European Union's corporate social responsibility (CSR) reporting mandate on the graph disclosure quality in sustainability reports. We document that firms produce better CSR graphs after the adoption of the European Union's Directive. This effect is concentrated in firms in countries that have high environmental performance, high regulatory environment ratings, or firms with low agency problems. We also find that CSR graphs contain value-relevant information pertaining to the long-term market and financial performance. Firms that continue to produce low-quality CSR graphs experience lower market and financial performance in the post-adoption periods. This paper has policy, practice, and research implications in emphasizing the importance of graphical disclosure to management and in informing standard-setters on the relevance of graphical presentation in CSR reporting.

Keywords: Corporate social responsibility (CSR); disclosure regulation; Directive 2014/95; European Union (EU); CSR graph disclosure quality.

JEL Classification: G18, G38, K22, K32, L21, M14, M41, M48

1. Introduction

A growing number of public companies worldwide are issuing sustainability reports on various financial economic, and non-financial environmental, social, and governance (ESG) sustainability performance. Management plays a vital role in integrating business sustainability into corporate culture, business environment, strategic plans, decisions, and corporate disclosures (Rezaee and Fogarty, 2019). In 2014, European Union (EU) passed several directives that mandate increases in corporate social responsibility (CSR) disclosures.[1] The EU corporate social responsibility directive (EU 2014) requires large firms to prepare and disclose nonfinancial ESG reports from the fiscal year 2017 and onwards. The directive aims to increase firms' CSR transparency and pressure EU firms to pursue more CSR activities and properly disclose their impacts on operational and financial performance. We investigate the effect of the European Union CSR reporting mandate on the quality of ESG graph presentation in providing value-relevant information to all stakeholders.

We select the EU's Directive and its effects on ESG graphical presentation in the context of EU settings for several reasons. First, a CSR reporting mandate can help firms monitor, manage, and measure their operational impacts on the environment and society and demonstrate commitment to CSR activities. Second, mandatory CSR reporting enables firms to make real changes to their business operations and corporate disclosures, in turn providing better and more CSR information to stakeholders (e.g., Beatty. Liao,

[1] We use corporate social responsibility (CSR) and environmental, social, and governance (ESG) sustainability interchangeably, consistent with the literature s (Rezaee, 2016; Khan, Serafeim, & Yoon, 2016; Christensen et al., 2021).

and Yu 2013; Chen, Young, and Zhuang 2013; Shroff 2017; Cao, Liang, and Zhan 2019). Third, the CSR reporting mandate could make it less costly for stakeholders to acquire and process relevant information, which motivates firms to provide more transparent CSR information (Merton 1987; Barber, Odean, and Lu 2005; Barron. Byard, and Kim 2002; Christensen, Floyd, Liu, and Maffett 2017; Amel-Zadeh and Serafeim 2018).

Consistent with Townsend and Shu (2010), we argue that graphical information can efficiently assist readers in understand and retaining complex information and thus firms could greatly improve CSR graphical presentation quality after the adoption of the EU's directive . However, prior research (e.g., Dryer, Lang, and Stice-Lawrence 2017) suggests firms often respond to a new disclosure requirement by extending their boilerplate disclosures. Consistent with this concern, firms could use boilerplate language as an avoidance strategy to comply with the CSR reporting mandate. Moreover, firms could present obfuscated information and distorted graphs for greenwashing purposes, that is, to gloss over or detract readers from poor CSR performance or even overclaim CSR activities to create a favorable impression (e.g., Crilly, Hansen, and Zollo 2016; Cho, Phillips, Hageman, and Patten 2009; Cho, Laine, Roberts, and Rodrigue 2015; Siano, Vollero, Conte, and Amabile 2017). Thus, it is unclear a priori whether the EU mandatory reporting directive would improve CSR reporting quality, especially graphical disclosure quality. These possibilities introduce tension in our research question of whether and how the CSR reporting mandate improves ESG graph quality for EU firms.

This is particularly an important research question because graphical presentation, a voluntary and unregulated disclosure style, is under management's discretion and management plays a crucial role in influencing readers' understanding of a firm's CSR

performance. Firms within the EU's directive scope are diverse in terms of industry, locations, and business models, associated with very different CSR reporting intentions and strategies. This diversity, in turn, reduces stakeholders' monitoring and benchmarking abilities and enables management to use its discretion in CSR reporting. Therefore, firms could use graphical disclosure as convenient communication media to achieve greenwashing purposes. As the enforcement of the EU directive is in its infancy, it is important to understand how management responds to this unprecedented mandatory disclosure regulation by using different communication media. Therefore, ex-ante, given management latitude in graphical CSR presentation, the relation between mandatory CSR reporting and the graph disclosure quality is an empirical question.

We begin our analyses by hand collecting the top 100 EU firms' graph information in the CSR reports from 2016 to 2020. In total, we collected 3,560 ESG graphs.[2] To measure the graph quality, we develop an ESG graph distortion index based on Steinbart's framework (1989) and prior financial graph quality research (e.g., Beattie and Jones 1996, 1997, 1998, 1999, 2008; Courtis 1997; Frownfelter and Linthicum 2001; Christensen, Fronk, Lee, and Nelson 2021). For a rectangular framework ESG graph, the distortion index evaluates sixteen presentation dimensions. Each dimension is measured by an indicator variable that captures the violation of a specific rule. The sum of sixteen indicators is the graph distortion index. Hence, the higher the index, the lower quality of the graph.

[2] The ESG graphs we collected are graphs that illustrate numeric information about environmental, social, or governance performance. These graphs are also accompanied by explanatory narratives in the CSR reports. There are two main categories of graphs that fulfill the requirements - rectangular framework graphs and pie graphs. In total, we collected 2,347 rectangular framework graphs and 1,213 pie graphs from 500 CSR reports.

The EU's directive was applied for the fiscal year 2017 and onward, meaning that the reporting mandate came into effect in 2018. We use a difference-in-differences design and estimate the yearly treatment effect for five years, from 2016 until 2020. Our findings document that EU firms, on average, decrease their ESG graph manipulation after the reporting mandate. Specifically, the ESG rectangular graph distortion index dropped about 0.397 units, equivalent to a 10% decrease relative to the mean. The ESG pie graph distortion index dropped about 0.322 units, equivalent to a 19.3% decrease relative to the mean. These findings suggest a significant improvement in the quality of graphical presentation in the post mandatory reporting period. We then separate graphs into specific categories (i.e., environmental, social, and governance) and find that the distortion index of each graph category is significantly reduced after the adoption of the EU's reporting mandate. This finding is robust to the entropy balancing analysis.

We conduct three cross-sectional analyses to investigate plausible variations in our treatment effect. Accordingly, the reduction of ESG graph distortion should be more pronounced for firms in an EU Member State with strong environmental performance or a strong business regulatory environment. We find consistent evidence supporting this notion. We also find the firm-level agency cost is another factor that significantly moderates the implementation effect on graphical quality.

Next, we examine whether the change in ESG graph quality driven by the EU reporting mandate would be associated with the better market and financial performance. Prior literature suggests that better disclosure can lead to tangible capital market benefits in the form of improved liquidity, lower cost of capital, higher asset prices (or firm value), and potentially better corporate decisions (Fama and French, 2007; Plumlee,

Brown, Hayes, and Marshall 2015; Gao and Zhang 2015; Barth, Cahan, Chen, and Venter 2017; Goss and Roberts 2011; Chava 2014). In other words, low quality ESG graph presentations would be associated with the negative market and financial consequences.

We argue that as the EU's reporting mandate should motivate firms to produce high quality ESG graphs that illustrate high quality ESG information, the firms that continue to produce low-quality ESG graphs (i.e., high graphical distortion) would be associated with lower long-term market return, lower financial performance, and higher market illiquidity. We use one year ahead buy-and-hold abnormal return to measure long term market performance and find that the post-adoption ESG graph distortion index is negatively associated with the future buy-and-hold return. We also find that post-adoption low quality ESG graphs are negatively associated with future return on assets. Moreover, low quality graphical information can increase investors' information processing costs, resulting in lower stock price informativeness. Consistently, we find that firms continuing to produce low quality ESG graphs are positively associated with future market illiquidity.

Our study makes several contributions. First, we contribute to the CSR reporting literature by documenting that firms improve the overall CSR report disclosure quality, including graphs, even though there are no graphical presentation guidelines in the EU's Directive. Second, we complement the corporate disclosure literature by showing that CSR graphs provide value-relevant information to market participants who need high-quality presentations to make better pricing decisions. Third, our finding is of potential interest to regulators and policymakers as our findings inform standard-setters on the importance of graphical presentation that should be included in their standards because

the successfulness of implementation depends on the specificity of the standards. Standard setters could consider expanding current initiatives by prescribing how firms can properly utilize graphs to present high quality CSR information to stakeholders. Fourth, management can use our results in assessing the potential benefits and costs of CSR mandatory reporting and graphical presentation. Fifth, our study provides evidence supporting the movement toward a widespread mandatory CSR disclosure by professional organizations (e.g., Global Reporting Initiative, Sustainability Accounting Standards Board, International Integrated Reporting Council, and Stock Exchanges). Finally, graph presentation could play a vital role in reducing boilerplate language, which is often a side effect of mandatory disclosure.

The remainder of the paper is organized as follows: Section 2 presents the literature review and hypothesis development. Section 3 describes our research method. Section 4 reports the descriptive statistics and our main empirical findings. Section 5 presents additional analyses, an section 6 concludes the paper.

2. Literature review and hypothesis development

2.1 The European Union CSR Directive

European Parliament passed Directive 2014/95 on April 15, 2014, intended to increase transparency and comparability of CSR disclosure by large EU firms (listed firms with more than 500 employees and with either more than EUR 20 million in total assets or more than EUR 40 million in sales) starting with the fiscal year 2017.

The EU Directive mandates an annual CSR report to present information on policies, risks, and outcomes related to environmental, social, human rights, anti-corruption, and

diversity issues. With respect to reporting guidelines, Article 1 and 2 further specifies how firms can prepare the nonfinancial reports using their existing reporting framework and how firms can develop specific implementation guidelines that can produce relevant, useful, and comparable non-financial information to stakeholders. Although the Directive requires member states to ensure proper enforcement mechanisms are in place to carry out the provisions, there is little information about the country-level enforcement institution or their activities and the manner of CSR disclosures.[3]

2.2 Graph disclosure quality in corporate disclosure

Recent technology advances, using photographic reproduction and electronic dissemination, enable management to present and investors to use visual communication. Compared to narratives, financial graphs have more power in assisting investors to understand the relationship between numeric information and allow them to identify changes in the trend of a firm's financial and nonfinancial conditions more quickly (Moriarity 1979). The graphical designs and colors in which financial data are presented by management can effectively influence the investors' judgment of performance results (Townsend and Shu 2010). Hence, graphs can enhance communication efficiencies and memorability. Although graphical presentation brings many benefits to information users, the quality of CSR graphs has received limited attention from accounting researchers. Researchers are mainly interested in understanding how firms use graphs to convey financial information and whether the management presents graphs to influence investors' impression of firms' financial performance.

[3] In the first year of Directive adoption, 2018, EU enforcement authorities reviewed a total of 918 CSR reports. Out of which 385 pertained to "existence and content". But EU authorities do not report any detailed information about the country-level compliance situation and the documentation of enforcement activities is quite generic.

Prior literature has uncovered three main graph impression management strategies. First, management may only draw graphs for financial variables when these measures are favorable (Steinbart 1989). Second, management may present graphs with systematic bias in presenting numerical relationships to geometric relationships, which can be quantified in graph distortion index (Taylor and Anderson,1986).[4] Several studies use this graphical distortion index and find that firms use financial graphs to exaggerate upward earnings trends and compress downward performance trends (Beattie and Jones 2001; Courtis 1997; Frownfelter and Linthicum 2001; Mather, Ramsay, and Serry 1996).[5] Third, prior studies extensively discuss inappropriate graphical construction and design choices that lead to misinterpretation or deception. For example, Courtis (1997) and Arunachalam, Pei, and Steinbart (2002) document many instances of graphical impropriety, such as manipulated baselines, absent gridlines, unsuitable graph types, and un-conventional trend presentation and the impact on readers' impressions. As prior literature has limited discussion on the quality of CSR graph disclosure, we believe the distortion and presentation issues that exist in financial graphs are common to CSR graphs.

2.3 Hypothesis development

The EU's Directive aims to increase transparency and comparability of CSR disclosure across EU member states. This expectation is premised on the regulators'

[4] Taylor and Anderson (1986) created the GDI factor. Mather, Mather, Ramsay (2005) follow up with a Relative Graph Discrepancy Index (RGDI), which is an upgraded version of the GDI. Both GDI and RGDI only capture one aspect of graphical manipulation —measurement distortion. GDI only measures whether the graphical representation is proportional to the numeric values represented.

[5] When the distortion index is positive, it means that the graphical presentation exaggerates (or overstates) the change in financial metrics. When the distortion index is negative, it means the graphical presentation understates the change in the financial metrics. Thus, a positive mean of the distortion index is associated with data trend exaggeration (i.e., overstatement).

belief that the reporting mandate can improve the quality of environmental and social information for several reasons. First, after reporting mandate, societal and stakeholders can easily access CSR reports and compare reporting quality among different firms, which reduces stakeholders' information processing costs (Merton 1987; Barber et al. 2005; Barron et al. 2002; Christensen et al. 2017; Amel-Zadeh and Serafeim 2018). Lower information processing costs potentially strengthen stakeholders' monitoring roles in firms reporting behavior (Bushman and Smith 2001; Lambert, Leuz, Verrecchia 2007; Flammer 2013; Christensen, Serafeim, and Sikochi 2021).

Second, the EU's Directive can stimulate peer benchmarking and learning activities (Beatty et al. 2013; Chen et al. 2013; Shroff 2017; Cao et al. 2019). The reporting laggers are pressured to produce more and better CSR information or engage in more CSR activities to match their peers. As CSR graphs can efficiently assist information decoding and effectively influence investors' understanding of sustainability activities, firms could produce and utilize high quality CSR graphs to improve the understandability of the CSR reports (Healy and Palepu 2001; Jensen 2001; Rezaee 2016). Third, graph presentation can help investors gauge the management reporting intention and attitude towards firms' environmental and social commitments. To signal the CSR commitments and build a better reputation, firms may produce high quality graphs because visual presentation has strong branding and memory retention effects (Jensen 2001; Rezaee 2016, Fiechter, Hitz, and Lehmann. 2020). Therefore, it is reasonable to project that CSR graph quality improves after the passage of the EU's Directive.

The passage of the EU's Directive could have an adverse effect on CSR disclosure quality for several reasons. First, prior literature suggests that firms often extend boilerplate disclosure in response to a new disclosure requirement (Dryer et al., 2017). In fact, an analysis of CSR reporting practices shows that most public firms often report repetitive, not tailored CSR information, and rarely disclose any quantitative information (SASB 2017). Thus, one would suspect whether the EU's multi-national reporting mandates could change firms' current reporting preferences, which eventually are determined by firm-specific evaluation of the cost-benefit tradeoff (Hail et al. 2018; Christensen et al. 2020). Second, to meet reporting requirements, firms may choose to implement CSR standards in a more "symbolic" way to legitimize corporate actions, selectively disclosing positive CSR activities without intending to materially adjust the underlying real activities (O'Sullivan and O'Dwyer 2009; Marquis, Toffel, and Zhou 2016; Diouf and Boiral 2017). Third, firms could also present obfuscated or distorted graphs to distract readers from discovering poor CSR performance (Crilly et al., 2016; Cho et al., 2009 and 2015; Siano et al.,2017). Finally, as the EU's Directive is an unprecedented act of supra-national disclosure regulation, the country-level enforcement institutions are hard to establish, which can cause observing limited documentation of the compliance with the EU's Directive (Fiechter et al. 2020). Without proper implementation and enforcement of the standard, it is hard to project that the CSR reporting quality would improve after the passage of the reporting mandate. Therefore, in line with this argument, it is unclear whether the EU's reporting mandate would improve CSR graph reporting quality, and we state the following hypothesis:

H1: There is no difference in the CSR graph disclosure quality before and after the passage of the EU's CSR reporting mandate.

3. Research method

3.1 Sample selection

We test our hypotheses by using a sample of large European firms.[6] Considering the massive hand-collection efforts, we focus on the top 100 European firms' sustainability reports from 2016 to 2020.[7] We compare European firms' ESG graph presentation quality before and after adopting the CSR reporting mandate. Our sample construction process starts with first downloading every sustainability report for the selected EU firms for the sample period. We then use each sustainability report to collect the ESG graphical quality data based on the nineteen graphical presentation quality dimensions (discussed in the *ESG graph distortion index* section*).* We hand-collected 3,560 ESG graphs in total.[8] The process of merging our graphical dataset with Compustat-Global, which provides financial information of the firm, resulted in 3000 graph-year observations. We use this sample to test H1. We then merge this dataset with Global Security daily datasets to obtain data for all control variables in additional analyses. The resulting final sample size is 1,956 graph-year observations as presented in Table 1.

Insert Table 1 Here

3.2 ESG graph distortion index

[6] The reason for choosing large firms is because the scope of the EU's Directive mandates is large, listed firms with more than 500 employees and with either more than EUR 20 million in total assets or more than EUR 40 million in sales.

[7] There are many possible disclosure outlets for ESG-related information (footnote disclosure, management D&A, separate sustainability reports), To be consistent, this study only examines firms' sustainability reports. The top 100 firms are selected based on their total asset. The majority (about 90%) of these firms already issue sustainability reports on their ESG performance even before the mandatory adoption.

[8] Our sample is based on the graph-year observation because the graphical disclosure quality varies within a firm in the same year. Each graph represents a different level of presentation quality. Thus, we prefer not to calculate a simple mean of graph quality to represent the firm's overall graphical disclosure quality. Doing so will diminish the accuracy of our graph distortion index measure. Thus, all regression analyses are based on graph-year observations.

We use Steinbart's framework (1989) and prior financial graph quality research (e.g., Beattie and Jones 1996, 1997, 1998, 1999, 2000, 2001; Courtis 1997; Frownfelter and Linthicum 2001; CICA 1993; Beattie and Jones 2008; Christensen et al., 2021) to construct a rectangular framework ESG graph distortion index (*ESG_GDI_REC*) and a pie ESG graph distortion index (*ESG_GDI_PIE*).[9] Both distortion indices measure the presentation infidelity of ESG graphs. In other words, the higher the graph distortion index, the lower the ESG graphs quality.

ESG_GDI_REC measures two categories of graph infidelity. The first category evaluates the quality of graph information input: (1) whether the graph misses its corresponding narratives *(MISS_NARRATIVE_INFO)*; (2) whether the graph data is inconsistent with the narrative data *(WRONG_INFO)*. The second category captures the graphical presentation enhancements. There are fourteen ways to use graphical elements in a rectangular graph to enhance the perception of the graph readers, as described in detail in Appendix A and Table A. In total, the *ESG_GDI_REC* captures sixteen dimensions of presentation infidelity of a single rectangular ESG graph. See the following equation (1):

$$ESG\_GDI\_REC_{i,t} = (MISS\_NARRATIVE\_INFO_{i,t} + WRONG\_INFO_{i,t}) + (MUTI\_Y_{i,t} + MISS\_Y\_NAME_{i,t} + MISS\_LABEL_{i,t} + BROKEN\_Y_{i,t} + DATA\_INSIDE_{i,t} + MISS\_LEGEND_{i,t} + REVERSE\_X_{i,t} + OBSTRUCT\_BACK_{i,t} + IS\_SECOND\_DIMENSION_{i,t} + MANY\_COLOR_{i,t} + IS\_3D_{i,t} + IS\_STACK\_BAR_{i,t} + IS\_HORIZON\_BAR_{i,t} + IS\_VISUAL\_AID_{i,t} \quad (1)$$

ESG_GDI_PIE measures three elements of graphical infidelity (Jones 1995; Tufte 1983). These elements are (1) whether each pie slice represents a percentage of the total value, (2)

[9] A rectangular framework-based graph contains detailed data information and casts a complete mapping between data and pictorial symbols. This kind of graph is built in a flat composed of two intersecting perpendicular lines (i.e., x and y-axis). The y-axis and x-axis represent different numeric variables. The flat area contains pictorial symbols that represent the numeric relationship between x and y variables. Usually, a CSR rectangular framework graph uses the x-axis to denote fiscal years and the y-axis to depict CSR information. We use CSR and ESG interchangeably.

whether there is rotation enhancement in the pie graph, and (3) whether the pie graph is in a donut shape. The sum of these three dimensions is the score of *ESG_GDI_PIE*. See the following equation:

$$ESG\_GDI\_PIC_{i,t} = IS\_NOT\_PERCENT_{i,t} + ROTATION\_EHANCE_{i,t} + IS\_DONUT\_PIE_{i,t} \quad (2)$$

3.3 Empirical models

We use Equation (3) to test the impact of the CSR reporting mandate on the ESG graph disclosure quality (H1):

$$\begin{aligned} ESG\_GDI\_REC/ESG\_GDI\_PIE_{i,t} = {} & \alpha_0 + \alpha_1 POST_{i,t} + \alpha_2 SIZE_{i,t} + \alpha_3 LEV_{i,t} + \alpha_4 SALE_{i,t} + \\ & \alpha_5 ACCRUAL_{i,t} + \alpha_6 ROA_{i,t} + \alpha_7 LOSS_{i,t} + \alpha_8 CAPEXP_{i,t} + \alpha_9 FINANACE_{i,t} + \alpha_{10} AR\_IN_{i,t} + \\ & \alpha_{11} GRAPH\_COUNT_{i,t} + \alpha_{12} EARNVOL_{i,t} + \alpha_{13} BIG4_{i,t} + \alpha \sum industry\ fixed\ effects + \\ & \alpha \sum year\ fixed\ effects + \alpha \sum country\ fixed\ effects + error \end{aligned} \quad (3)$$

The EU's directive was passed in April 2014 and applied for fiscal years 2017 onwards with the effective year of 2018. Thus, the independent variable *POST* equals one if the graph-year observation is in the year 2018 or after, zero otherwise. We have no directional expectation of α_1 because it is unclear whether the CSR reporting mandate would incentivize management to improve ESG graph quality or produce more distorted ESG graphs to cover up or enhance readers' perception of CSR performance. Following Perera, Jubb, and Gopalan (2019), we control for the firm's size (*SIZE*), leverage (*LEV*), and sales (*SALE*). Lo, Ramos, and Rogo (2017) suggest firms that experience poor financial performance may be more likely to engage in impression management. We thus control for *LOSS*, earnings volatility (*EARNVOL*), and *ROA*. Prior literature also suggests that a firm's financing needs, stock liquidity risk, and firm's capital expenditure might influence its incentives to engage in CSR activities (McWilliams and Siegel 2000; Nazari, Hrazdil, and Mohmoudian 2017). We include corporate financing activities

(*FINANCE*), percentage of inventory and account receivable (*AR_IN*), and capital expenditure (*CAPEXP*) in the model. We include factors associated with the firm's financial reporting quality and graphical practice by controlling for the absolute value of discretionary accrual (*ACCRUAL*), Big 4 auditor indicator (*BIG4*), and the number of graphs in the ESG report (*GRAPH_COUNT*). Last, following prior literature, we include year and industry fixed effects. We also control for country fixed effects as different countries in European Union have drastically different institutional environments. We use Huber-White robust standard error to control for heteroskedasticity in the panel data. All above variables are defined, and data sources are provided in Appendix B.

4. Results

4.1 Univariate analysis

Table 2-Panel A presents the sample statistics of variables used in the H1 analysis. All variables are winsorized at 1st and 99th percentiles. The mean of *ESG_GDI*_REC is 3.9352, which suggests that firms breach about 4 out of 16 rectangular graph presentation rules. The mean of *ESG_GDI_PIE* is 1.6663, suggesting the firms breach about 2 out of 3 pie graph presentation rules. The mean of *POST* is 0.6033 because our sample period covers the pre-adoption period (i.e., the years 2016 and 2017) and the post-adoption period (i.e., the year 2018 to 2020). We also break down *ESG_GDI_REC* into environmental, social, and governance rectangular graph quality measures (i.e., *GDI_REC_ENVIORN*, *GDI_REC_SOCIAL*, *GDI_REC_GOVERN*). The distortion means of these subcategories of rectangular graphs are similar to the mean of *ESG_GDI_REC*. Similarly, the distortion means of environmental, social, and governance pie graphs are similar to the mean of *ESG_GDI_PIE*. The mean of *ACCRUAL* is 0.0352, which is consistent with prior literature. Our sample firms, on average, have 110-billion

dollars in assets, 19.8% leverage, 2.6% return on assets, 78-billion-dollar sales, 19% of inventory and account receivable to total asset, 0.0199 earnings volatility during the past four years. About 15% of sample firms experience loss, 31% engage in financing activities, and 85% use the Big 4 as auditors over the sample period. The sample statistics are consistent with our study scope, indicating that the sampled 100 firms are big, mature, stable, profitable, and have high financial reporting integrity.

Table 2- Panels B presents the sample statistics of variables used in additional analyses: the moderation effect of the reporting mandate on the relationship between ESG graph quality and firms' long-term financial and market performance. We measure the long-term market performance by using future one-year abnormal buy-and-hold return (*FUT_BHAR*) and change of one-year buy-and-hold return (*CHANGE_BHAR*). The mean of *FUT_BHAR* is -0.056, suggesting the sample firm's yearly buy and hold return is 5.6% less than the market. The sample means of *CHANGE_BHAR* and the current year *BHAR* are -0.0486 and -0.0115, respectively. We also examine the relationship between ESG graph quality with future one-year market illiquidity (*FUT_ILLIQUID*) and change of one-year illiquidity (*CHANGE_ILLIQUID*). The mean of *FUT_ILLIQUID* is 0.0471, representing the absolute value of returns relative to the daily value traded is 4.7%. The sample means of *CHANGE_ILLIQUID* and the current year *ILLIQUID* are 0.0001 and 0.0458, respectively. The rest of the variables have consistent sample statistics as those in the main sample. Table 3 presents the Pearson correlations of all variables used in our study. The significant correlations of all variables are all below 0.60.[10]

Insert Tables 2 and 3 Here

[10] We conduct multi-collinearity diagnostic tests for all the explanatory variables in the models and review the VIFs for each explanatory variable. There is no indication of multi-collinearity that would affect our regression inferences.

4.2 Regression results

The impact of CSR reporting mandate on the ESG graph quality

Table 4 presents the H1 regression results. The model specification is based on Equation (3). Column (1) reports the OLS regression result of the relationship between *POST* and *ESG_GDI_REC*. We find that the coefficient on POST is significantly negative (-0.397, p<0.l), suggesting EU firms disclose higher quality rectangular ESG graphs after the CSR reporting mandate. Column (2) reports the regression results of the relationship between POST and *ESG_GDI_PIE*. We find that the coefficient on POST is also significantly negative (-0.322, p<0.01), suggesting EU firms disclose better quality pie ESG graphs after the reporting mandate. These findings suggest that the ESG graph quality is significantly improved after the adoption of the EU's Directive.

Regarding control variables, the coefficients on *LEV* are consistently negatively significant in both columns (-6.727 and -2.184, p<0.01), suggesting firms that are highly levered are less likely to manipulate ESG graphs. This is consistent with the notion that lenders exert monitoring on firms' disclosure quality (Goss and Roberts 2011; Chava 2014; Cheng, Ioannou, and Serafeim 2014; Kim, Surroca, and Tribo 2014; Cheng, Wang, Zhang, and Zhao 2017). The coefficient on ROA is significantly negative in both columns (-9.587 and -8.851, p<0.01), indicating profitable firms are less likely to use distorted financial graphs to influence readers' perception, consistent with the finding of Beattie and Jones (2008).

Insert Table 4 Here

We further separate ESG graphs into environmental, social, and governance graphs.[11] Table 5 presents the regression results of how the mandatory ESG reporting standard influences the quality of each subcategory of rectangular ESG graphs. In column (1), we detect a significantly negative coefficient on *POST* when the dependent variable is *GDI_REC_ENVIORN*. This suggests that EU firms improve environmental rectangular graphs quality after the CSR reporting mandate. Similarly, in column (2), we detect a significant negative coefficient on *POST* where the dependent variable is *GDI_REC_SOCIAL*, suggesting the firm improves the social graph presentation quality after the mandatory CSR reporting adoption. We fail to detect any significant coefficient on *POST* when the dependent variable is *GDI_REC_GOVERN* because the sample size of governance ESG graphs is fairly small.

Insert Table 5 Here

Like rectangular ESG graphs, we also separate ESG pie graphs into three categories: environmental, social, and governance graphs. In Table 6, similar to the findings in rectangular ESG graphs, we find significantly negative coefficients on POST in columns 1 and 2, where the dependent variables are environmental and social pie graph measures. This suggests that firms improve pie graph presentation quality after the adoption of the CSR reporting mandate. As the sample size is also small for governance pie graphs, we fail to detect any significant coefficient on *POST*.

[11] Environmental graphs include graphs depict information about air emission, energy consumption, waste outputs, water usage, local environmental community data, waste, recycling, materials usage, wastewater, industry specific data, travel data, transport data, fuel efficiency data, environmental expenditure, noise pollution, environmental scoping, environmental incidents, and contaminated land, etc. Social graphs depict information about employee data, lost time and illness, work accidents, gender and racial equality, charitable activities, employee training spending, employee health and safety, corporate social responsibility outreach, labor complaints, etc. Governance graphs depict information about data security, corporate social responsibility leadership, corporate social responsibility risks, corporate social responsibility management system, corporate social responsibility executive participation, etc.

Insert Table 6 Here

4.3 Robustness check – Entropy balancing

We employ the entropy balancing matching approach to check the robustness of H1 findings. Entropy balancing preserves the full sample while reweighting the observations so that the post-weighting average and variances of matching variables are nearly identical for POST=1 and POST=0 observations (Chapman, Miller, and White, 2019; Agarwal, Vashishtha, and Venkatachalam 2018). In doing so, entropy balancing allows unit weight to vary smoothly across units, rather than assigning a weight of 0 (unmatched and discarded) or 1 (matched and retained) used in propensity score-matched techniques.

Table 7- Panel A reports that, after entropy balancing, the means and variances for the matching variables are nearly identical between the treatment (POST=1) and control (POST=0) groups. Table 7 - Panel B reports the results from estimating Equation (3) using post-entropy balancing weights. Consistent with H1, we find significant negative coefficients on POST, suggesting firms improve graphical presentation quality after the mandatory disclosure of ESG reporting in Europe Union countries.

Insert Table 7 Here

4.4 Cross-sectional analyses

We conduct three cross-sectional tests to investigate plausible variations in our treatment effect. Specifically, we examine whether the environmental performance index, business regulatory environment strength, or executives' equity compensation has modifying effects on the post-adoption ESG graph disclosure quality.

First, we measure the environmental performance of each EU Member State by using the environmental performance index (EPI) published by Yale University.[12] EPI index ranks 180 countries on 24 performance indicators across categories covering environmental health and ecosystem vitality. This metric provides a gauge at a national scale of how close countries are to established environmental policy goals and offers a scorecard that highlights leaders and laggers in the environmental performance. The higher the EPI, the better the environmental performance of that country. We project that firms in countries with high EPI scores would have better post-adoption ESG graphical quality than firms in countries with low EPI scores. This is because high environmental performance countries have the regulatory infrastructure, resources, and cultural background to support and monitor the implementation of the CSR reporting mandate. Firms under an institutional background with high environmental performance are more likely to comply with the reporting mandate and improve CSR reporting quality, leading to better ESG graph disclosure.

Table 8 columns (1) and (2) present the EPI cross-sectional regression result. We split the main sample based on an indicator variable HIGH_EPI, which equals one if the firm's EPI is higher than the sample mean of EPI and zero otherwise. We find that the coefficient on POST is significantly negative (-1.999, $p<0.01$) when HIGH_EPI equals one, whereas the coefficient on POST is significantly positive (+1.571, $p<0.01$) when HIGH_EPI equals zero. This suggests that firms in high environmental performance countries improve their ESG graph disclosure quality significantly after passing of CSR reporting mandate, whereas firms in low environmental performance countries make worse quality ESG graphs after passing of CSR reporting mandate.

[12] The data is available at https://epi.yale.edu/.

In sum, the environmental performance of an EU member state can modify how a firm reacts to the CSR reporting mandate.

Second, we examine whether a country's business regulatory environment can modify firms' responses to the CSR reporting mandate. We use the Country Policy and Institutional Assessment (CPIA) business regulatory environment rating to assess the extent to which the legal, regulatory, and policy environment help or hinder businesses in investing, creating jobs, and becoming more productive.[13] A high CPIA regulatory rating suggests a country has a policy and institutional framework that strongly fosters growth and poverty reduction. We project that firms in a high regulatory rating environment would be more likely to comply with regulatory change because such an institutional environment can better support CSR growth and more closely monitor CSR performance. As such, firms in these countries would improve their ESG reporting quality after the EU's reporting mandate. Table 8, columns (3) and (4) report the regression results. We split the main sample based on an indicator variable HIGH_LEGAL, which equals one if the firm's CPIA regulatory index is higher than the sample mean and zero otherwise. We find that the coefficient on POST is significantly negative in column 3 (-0.591, $p<0.05$), where HIGH_LEGAL equals one, whereas the coefficient on POST is insignificant in column 4 where HIGH_LEGAL equals zero. This suggests that firms in a high rating business regulatory environment improve their ESG graph disclosure quality significantly after passing the CSR reporting mandat,e, whereas firms in a low rating business regulatory environment have no significant change in their ESG graph presentation. Thus, a country's business regulatory environment modifies how a firm reacts to the CSR reporting mandate.

[13] CPIA regulatory environmental rating is published by the World Bank. CPIA index assesses a set of 16 criteria grouped into four categories: economic management, structural policies, policies for social inclusion and equality, and public sector management and institution. The higher the CPIA regulatory index, the better the regulatory environment for business growth. It is available at https://data.worldbank.org/indicator/IQ.CPA.BREG.XQ

Third, we examine whether a firm's executive compensation structure influences the post-adoption ESG graph quality. Due to agency problems, executives with high equity-based compensation are more likely to engage in opportunistic reporting behavior (Hoi, Wu, and Zhang, 2019; Efendi, Srivastava, and Swanson 2007; Adut, Holder, and Robin, 2013). We thus conjecture that executives with high equity-based compensation are more likely to engage in opportunistic CSR reporting practices due to increased stakeholder pressure. However, executives with low equity-based compensation are more likely to comply with the CSR reporting regulation to produce better quality ESG graphs after the reporting mandate. To test this projection, we split the sample based on an indicator variable HIGH_INCENT, which equals one if a firm's executive stock compensation is higher than the sample mean and zero otherwise. Table 8 columns (5) and (6), present the results. We detect a significant negative coefficient on POST (-1.699, $p<0.01$) in column (6), where HIGH_INCENT equals zero but an insignificant coefficient on POST in column (5), where HIGH_INCENT equals one. This finding suggests that executives with low equity-based compensation would be more likely to produce better ESG graphs after the reporting mandate than those with high equity-based compensation. In sum, the agency problem related to the executive compensation structure influences the management's graph reporting behavior after the CSR reporting mandate.

Insert Table 8 Here

5. Additional Analysis

In this section, we discuss whether the change in ESG graph quality driven by the CSR reporting mandate would be associated with higher stock returns, lower market illiquidity, or better financial performance. [14]

5.1 Post-adoption ESG graph quality and long-term market performance

Enlighted value maximization theory suggests that a proper balance between financial-economic sustainability and non-financial ESG sustainability could maximize firm value (Jensen 2001). More transparent and high-quality sustainability disclosure on long-term economic and ESG performance creates opportunities to identify and correct operational inefficiencies, reputation, and financial risks, resulting in increases in a firm's value. Also, Leuz and Wysoki (2008) suggest that the net benefits of disclosing sustainability information at the firm level would create market-wide benefits. If sustainability information is viewed as value-relevant by investors and has net benefits to the firms that are not fully internalized, then we should observe positive market consequences for high-quality sustainability disclosure.

There are two reasons why graphical information would matter to the market participants. First, human has limited cognitive processing abilities (Newell and Simon 1972; Kahneman and Tversky 1986). As graphical information can better stimulate readers' comprehension and memorization, reducing the information processing costs, firms that commit to reporting transparency are willing to produce good quality sustainability graphs to improve the communication efficiencies with stakeholders. Also, disclosure via graphical format strengthens investors' awareness of firms' social responsibility commitment. Such commitment reflects a

[14] As the sample size of ESG pie graphs is significantly smaller than rectangular ESG graphs. The additional analyses only discuss and test the relationship between the rectangular ESG graph quality and the long-term market and financial performance.

firm's low agency problems, which are often associated with positive financial and market performance (Ng and Rezaee 2020). Second, the costs and benefits of sustainability graphical disclosure are often results of the management's visions and strategies. The disclosed level of private information about firms' environmental, social, and governance initiatives is often optimized by management. Hence, the observed level of ESG disclosure quality reflects firms' commitment to long-term sustainable goals. Based on these reasons, we expect a negative relation between the ESG graph distortion index and the long-term market performance. We use the future one-year abnormal buy and hold return to measure long-term market performance (FUT_BHAR). Moreover, if the CSR reporting mandate motivates firms to provide better quality sustainability disclosure. The increases in ESG graph distortion index in the post-adoption period (ESG_GDI*POST) should be negatively associated with the future buy-and-hold abnormal returns.

Table 9 presents the regression result of the relationship between the ESG graph quality and the long-term market performance. The dependent variable in column (1) is the future one-year buy and hold abnormal return, FUT_BHAR. The independent variable is the ESG graph distortion index, ESG_GDI_REC. We detect a significant negative association between ESG_GDI_REC and FUT_BHAR (coefficient=-0.019, $p<0.01$), suggesting low quality ESG graphs are associated with low future buy and hold return. In column (2), the dependent variable is the difference between next year's buy and hold return and the current year's buy and hold return, CHANGE_BHAR. We detect a significant negative coefficient on ESG_GDI_REC (-0.023, $p<0.01$), suggesting the current year's low quality ESG graph presentation is associated with decreases in future abnormal buy-and-hold returns. In column (3), the study of interest is ESG_GDI*POST, and the dependent variable is FUT_BHAR. We find a significant negative

coefficient on ESG_GDI*POST, suggesting the post-adoption ESG graph distortion is associated with lower future buy and hold abnormal returns than the pre-adoption graph distortion. In other words, the market punishes firms that continue to produce low quality ESG graphs after passing the EU's CSR reporting mandate.

Insert Table 9 Here

5.2 Post- adoption ESG graph quality and long-term financial performance

Similar to the discussion about long-term market performance, firms that are willing to produce high quality sustainability information commit to information transparency. Such commitment reflects low agency problems are associated with positive financial performance. Furthermore, firms that produce high quality ESG information are more honest and less likely to smooth earnings so that they do not deviate from the firm's long-term growth, that increases firm value (Gao and Zhang 2015). In the line of this argument, we conjecture that firms with low quality ESG graph presentations (i.e., high ESG_GDI_REC) are associated with low financial performance. Also, if the CSR reporting mandate motivates firms to provide better quality ESG graphs that depict value-relevant information to stakeholders, the increases in post-adoption graphical distortion (ESG_GDI*POST) should be negatively associated with future ROA.

Table 10 presents the regression result of the relationship between ESG_GDI_REC and return on assets (ROA). In column (1), where the dependent variable is future one-year ROA (FUT_ROA), we find a significant negative coefficient on ESG_GDI_REC (-0.001, $p<0.01$). This suggests that low quality ESG graph disclosure is associated with low financial performance. In column (2), the dependent variable is CHANGE_ROA, which equals ROA in year t+1 minus ROA in year t. We also find a significant negative coefficient on ESG_GDI_REC

(-0.001, p<0.01), suggesting the current year's low quality ESG graph disclosure is associated with decreases in future financial performance. In column (3), the study of interest is ESG_GDI_REC*POST, and the dependent variable is FUT_ROA. We find a significant negative coefficient on ESG_GDI_REC*POST, suggesting the post-adoption low quality ESG graph presentation is negatively associated with future financial performance. In other words, firms that continue to produce low quality ESG graphs after the EU's reporting mandate experience lower financial performance in the post-adoption periods.

Insert Table 10 Here

5.3 Post-adoption ESG graph quality and the market illiquidity

If ESG graphs provide firm-specific value-relevant information and investors can understand these graphs' implications on firm values, ESG graph disclosure should improve stock price informativeness. For example, Barth et al. (2017) show that following the 2010 integrated reporting mandate for firms listed on the Johannesburg Stock Exchange, firms with high-quality integrated reports and with larger yearly changes in reporting quality have lower bid-ask spreads and higher firm value. Grewal, Hauptmann, and Serafeim (2020) also find a negative relation between material CSR disclosure and bid-ask spreads. In addition, if firms perceive the expected benefits of disclosing high quality ESG graphs exceed the expected costs, this can generate the prediction that ESG graph quality improves price informativeness. For example, Cornier and Megnan (1999) show that a set of Canadian firms' trading volumes is positively associated with a voluntary CSR disclosure score. Cho, Freedman, and Patten (2012) find a negative association between voluntary CSR disclosure scores and information asymmetry. Thus, we project that high quality ESG graphs are associated with higher market liquidity. Moreover, if the EU's reporting mandate motivates firms to provide more value-

relevant sustainability information to stakeholders, the post-adoption high quality ESG graph disclosure (i.e., low ESG_GDI_GDI) should be associated with low market illiquidity. In other words, the increases in ESG graph distortion in the post-adoption periods (ESG_GDI_REC*POST) should be positively associated with market illiquidity.

Table 11 presents the regression result of the relationship between ESG_GDI_REC and future market illiquidity. We follow Grewal et al. (2020) to measure market illiquidity, which equals the natural log of the yearly average daily price impact of a trade.[15] In column (1), we use the future one-year market illiquidity (FUT_ILLIQUID) as the dependent variable. We find a significant positive coefficient on ESG_GDI_REC (+0.002, $p<0.01$), suggesting low quality ESG graph is associated with high market illiquidity in the future year. In column (2), the dependent variable is the change of illiquidity (CHANGE_ILLIQUID), which equals year t+1's illiquidity minus year t's illiquidity. We find a significant positive coefficient on ESG_GDI_REC (+0.002, $p<0.01$), suggesting the current year's low quality ESG graph presentation is associated with an increase in the future year's market illiquidity. In column (3), where the study of interest is ESG_GDI_REC*POST, we find a significant positive coefficient on ESG_GDI_REC*POST. This finding suggests firms that continue to produce low quality ESG graphs after the EU's reporting mandate experience higher market illiquidity in post-adoption periods than in pre-adoption periods. Namely, the market punishes firms that still produce low quality sustainability information after the CSR reporting mandate.

Insert Table 11 Here

[15] Illiquidity of stock (ILLIQUID) equals the absolute value of stock price return times 100 relative to the stock price times trading volume scaled by 1000: [Return*100]/(Price * Volume/1000). A higher value of ILLIQUID reflects a greater price change per dollar of daily trading. Amihud (2002) shows that this measure is strongly related to other illiquidity measures, such as the microstructure estimate of illiquidity and the Amihud measure.

6. Conclusion

This paper provides evidence on the impact of the EU's CSR Directive reporting mandate on ESG graph reporting quality. We find that firms improve their ESG graphical disclosure quality in response to the directive. These effects are concentrated in firms in countries that have high environmental performance, strong business regulatory environment, and firms with low agency costs. We further document that low ESG graph reporting quality is negatively associated with the long-term stock return, market liquidity, and financial performance. Moreover, firms that continue to produce low-quality ESG graphs after the CSR reporting mandate experience lower market and financial performance in the post-adoption periods than in pre-adoption periods. In other words, the market punishes firms that do not improve CSR reporting quality after the EU's Directive.

Our findings are subject to limitations. First, our paper only presents early evidence of the EU's reporting mandate. Future research can expand the sample period to provide more robust evidence. Second, we caution that our findings are specific to the sample firms in our study. Due to the massive hand-collection of CSR graphical data, our sample represents a subsample of EU firms within the scope of the CSR Directive. We leave it to future research to explore new technologies to capture the graphical elements from CSR reports.

Limitations aside, our paper is the first study to provide evidence on the impact of the CSR reporting mandate on the ESG graphical presentation quality. This evidence is not only of potential interest to regulators in the evaluation and shaping of CSR disclosure regulation but also enhances our understanding of the management's disclosure intentions and strategies in response to a mandatory CSR reporting regulation. The findings carry important insight for policymakers by highlighting an important benefit of mandatory CSR reporting. Our study

extends the literature and shows that the stock market, financial and liquidity consequence of mandatory CSR reporting. Our findings present practical implications for firms and their board of directors and management in considering the move toward voluntary CSR reporting as the board of directors can set a tone at the top in promoting CSR reporting, and management makes commitment to CSR factors of performance, risk and disclosure.

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Appendix A

ESG_GDI_REC Index Variable Definitions

Variable name	Definition
MISS_Y_NAME	MUTI_Y: when multiple y-axis scales are presented in the same framework, graph readers can misinterpret the magnitude of specifiers' changes (CICA 1993; Frownfelter and Linthicum 2001). Theoretically, based on sensory psychophysics, Cleveland and McGill (1984; 1986; 1987) emphasize that the most accurate human judgment regarding the position is along only one y-axis. Empirically, Taylor and Anderson (1986) find that the use of multiple y-axis scales negatively impacts participants' perception of the firm's value. Therefore, we set MUTI_Y to one if the performance graph in year t includes more than one y-axis and zero otherwise:
MISS_LABEL	MISS_LABEL: the numeric label of each axis represents the graph's measurement intervals, and it should be written close to the axis as much as possible. The numeric label specifies the data type and measurement unit. It links the magnitude of pictorial relationship to the magnitude of data relationship. Without the numeric label, readers cannot judge whether the graph is subject to visual distortion (Frownfelter and Linthicum 2001; Beattie and Jones 2008). Thus, WE set MISS_LABEL to one if the y-axis or x-axis of the stock performance graph in year t misses the numeric label and zero otherwise
MULTI_Y	MUTI_Y: when multiple y-axis scales are presented in the same framework, graph readers can misinterpret the magnitude of specifiers' changes (CICA 1993; Frownfelter and Linthicum 2001). Theoretically, based on sensory psychophysics, Cleveland and McGill (1984; 1986; 1987) emphasize that the most accurate human judgment regarding the position is along only one y-axis. Empirically, Taylor and Anderson (1986) find that the use of multiple y-axis scales negatively impacts participants' perception of the firm's value. Therefore, we set MUTI_Y to one if the performance graph in year t includes more than one y-axis and zero otherwise
BROKEN_Y	If there is missing numeric value in the middle of y-axis, we code this variable to 1; 0 otherwise.
DATA_INSIDE	DATA_INSIDE: data should not be shown inside of the framework. Tufte (1983) emphasizes that every drop of ink in the graph should convey useful information. As stock return data is already shown in a table format (as required by the SEC), it should not be shown again inside the framework. Hence, we set DATA_INSIDE to one if the framework of performance graph in year t contains financial data and zero otherwise;
MISS_LEGEND	MISS_LEGEND: A graph legend indicates the meaning of each specifier. It assists readers in matching geometry patterns and colors with data series. Readers use the legend to decode pictorial information (Beattie and Jones 2008). Therefore, we set MISS_LEGEND to one if the stock performance graph in year t misses the legend and zero otherwise
OBSTRUC_BACK	OBSTRUCKBACK: the background of a graph can be white, colored, or patterned; however, it should not be distracting to the extent that the graphical information flow from preparers to readers is interrupted (Jarett 1983; Kosslyn 1989). Thus, it is considered low presentation quality when the performance graph's background is obstructive. We set OBSTRUCK_BACK to one if the background of the stock performance graph in year t is pictorial or distracting and zero otherwise
IS_3D	IS_3D: it is important to show data variation, not design variation. A 3-D graph makes readers consider the value of a third dimension. The direction/thickness of specifier's shadow generates perceptual ambiguity. Thus, a 3-D specifier should be avoided (Tufte 1983; Jarett, 1983; Frownfelter and Linthicum 2001). Thus, we set IS_3D to one if the stock performance graph in year t is in a 3-D format and zero otherwise.
IS_SECOND_DIM ENSION	The IS_SECOND_DIMENSION variable captures a low-quality disclosure practice in which firms highlight favorable numeric information. For instance, firms often use a different color, bar width, or volume to capture readers' attention that the current year performance is better than that of preceding years. This tactic is called second dimension

	manipulation. Opportunistic managers induce readers' misinterpretation by manipulating the graphic dimensions that are supposed to be constant.
REVERSE_X	REVERSE_X: when the x-axis represents time, it should not be presented in a reverse time-series format. The reverse time series subverts the intuitions of the reader about time, as the intuitive presentation format of time on the x-axis should be in chronological order, which runs from left to right (Jones 1995). Empirically, Arunachalam et al. (2002) present a reverse year-series graph to their research participants and found the reverse time series affects graph readers' perception of company performance. As a result, investors' decision making is also affected. Thus, we set REVERSE_X to one if the performance graph presents in year t has a reverse time series on the x-axis and zero otherwise.
MANY_COLOR	MANY_COLOR: although graph designers use colors to highlight information that they want readers to pay attention, colors can occasionally be distracting. When too many colors are presented in one single graph, separating the colors can overload readers' working memory. As such, a maximum of six colors (including black and white) are allowed in a financial graph (Frownfelter and Linthicum 2001). Hence, we set MANY_COLOR to one if the stock performance graph in year t contains more than six colors, including black and white and zero otherwise.
MISS_NARRATIVE_INFO	If there is no table or no narrative information supporting the graphical information, we code this variable to 1; 0 otherwise
WRONG_INFO	If the information depicted in the graph does not match with the information in the table or narrative, we code this variable to 1; 0 otherwise
IS_STACK_BAR	The IS_STACK_BAR variable denotes that the firm uses a stacked bar to depict a key accounting variable. we consider using a stacked bar an opportunistic reporting practice because a stacked bar is often confusing (Jones 1995). More importantly, it is not suitable for presenting accounting metrics. First, a stacked bar can be used to show both relative sizes and actual values. However, the relative position of the areas can be confusing to readers. Are the areas vertically (like bricks and mortar) or layered on top of one another —such as drawing on separate transparent sheets with each new area starting on the same horizontal line at the bottom of the chart? If the areas are truly stacked, only the bottom data series will have a flat baseline. Each new area will take the top of the preceding one as its baseline, and any fluctuation in that line will distort the highs and lows in the series above. Therefore, due to visual confusion and various ways of interpretation, a stacked bar should not be used to present financial accounting metrics, and as such, we treat it as an opportunistic reporting choice of management
IS_HORIZONTAL_BAR	The IS_HORIZON_BAR variable records the cases in which the firm uses a horizontal bar graph to portray an accounting metric. We consider the horizontal bar format as low-quality disclosure because turning vertical charts into a horizontal format subverts the readers' intuitions about quantity (up-down) and time (left-right) (Jones 1995). Laying a vertical chart on its side can be a form of subtle deception because readers confuse the intuitive meanings of up-down and left-right format. In a horizontal bar, the position of the axes has been transposed: the x-axis—which usually represents years—runs up and down while the y-axis—which usually represents quantity—runs left to right. The graph reader will need a moment to adjust the counterintuitive layout. A sophisticated and opportunistic graph designer can use this slight delay in comprehension to achieve the misleading purpose. Another reason that a horizontal bar could be deceptive is that such bars are usually perceived as dependent on time and progressing toward a goal, and longer bars will be closer to the goal. When horizontal bars are used to depict the cost of goods sold, a longer bar does not mean approaching the goal but, in fact, higher costs. Thus, we treat a horizontal bar as an opportunistic reporting choice of management.
IS_VISUAL_AID	The IS_VISUAL_AID variable denotes the situation in which the firm uses a visual aid to facilitate a reader's interpretation of the data trend. The use of visual aid is well-adopted and effective tactic. However, it is considered opportunistic disclosure behavior because visual aids trick readers into following the visual clues provided by graphical designers and interferes with readers' independent visual-signal encoding processes. Opportunistic graph

	designers add visual aids to manipulate readers' comprehension of the data trends. In financial accounting graphs, we consider using visual aid as signs of opportunistic reporting behavior (Jones 1995; Frownfelter and Linthicum 2001).
IS_NOT_PERCENT	IS_NOT_PERCENT variable denotes a situation in which firm fail to use percentage to present the numeric information in a pie chart. In doing so, it reduces the readers' chances to understand the relative relationship among each pie slice, reducing the information decoding efficiency (Jones 1995.
ROTATION_ENHANCEMENT	ROTATION_ENHANCEMENT variable denotes a situation in which the biggest pie slice sits located on the right hand-side of the pie. Such presentation can create visual illusion that the biggest slice is bigger than its numeric proportion (Jones 1995.
IS_DONUT_PIE	IS_DONUT_PIE variable denotes a situation in which the pie graph is in a donut shape. Donut pie reduces readers' visual ability to accurately assess the relative proportion among different pie slice, reducing information decoding efficiencies (Jones 1995.

Table A

Panel A -Sample statistics of *ESG_GDI_REC* component variables

variable	N	mean	sd	median	min	max
MISS_Y_AXIS	2067	0.3585	0.4797	0.0000	0.0000	1.0000
MISS_NUMERIC_LABEL	2067	0.4747	0.4995	0.0000	0.0000	1.0000
MULTIPLE_SCALE	2067	0.0521	0.2223	0.0000	0.0000	1.0000
BROKEN_Y_AXIS	2067	0.0395	0.1948	0.0000	0.0000	1.0000
DATA_POINT_INSIDE_GRAPH	2067	0.7536	0.4421	1.0000	0.0000	1.0000
MISS_LEGEND	2067	0.4296	0.4951	0.0000	0.0000	1.0000
OBSTRUCTIVE_BACKGROUND	2067	0.0263	0.1601	0.0000	0.0000	1.0000
3D_DISPLAY	2067	0.0049	0.0696	0.0000	0.0000	1.0000
SECOND_DIMENSION_DISTORTION	2067	0.3824	0.4871	0.0000	0.0000	1.0000
REVERSE_TIME_SERIES	2067	0.0755	0.2643	0.0000	0.0000	1.0000
TOO_MANY_COLOR	2067	0.0529	0.2239	0.0000	0.0000	1.0000
MISS_NUMERIC_INFO	2067	0.5229	0.4996	1.0000	0.0000	1.0000
WRONG_NUMERIC_INFO	2067	0.2222	0.4158	0.0000	0.0000	1.0000
IS_STACK_BAR	2067	0.1979	0.3985	0.0000	0.0000	1.0000
IS_HORIZONTAL_BAR	2067	0.3062	0.4610	0.0000	0.0000	1.0000
IS_VISAL_AID	2067	0.0845	0.2782	0.0000	0.0000	1.0000

Panel B -Sample statistics of *ESG_GDI_PIE* component variables

variable	N	mean	sd	median	min	max
IS_NOT_PERCENTAGE	933	0.2860	0.4521	0.0000	0.0000	1.0000
ROTATION_ENHANCEMENT	933	0.5652	0.4960	1.0000	0.0000	1.0000
IS_DONUT_PIE	933	0.8261	0.3792	1.0000	0.0000	1.0000

Table 12 presents the descriptive statistics for each graphical element in the ESG_GDI_REC and ESG_GDI_PIE variable.

Appendix B - Regression Analysis Variable Definitions

Variable name	Definition	Data source
ESG_GDI_REC	=sum of sixteen graphical quality indicators of a rectangular ESG graph (See Appendix A for detailed definition of each graphical quality indicator). Increasing value of ESG_GDI denote lower quality of ESG graphs.	Hand-collected
GDI_REC_ENVIORN	=sum of sixteen graphical quality indicators of an environmental rectangular ESG graph (See Appendix A for detailed definition of each graphical quality indicator). Environmental graphs include graphs depict information about air emission, energy consumption, waste outputs, water usage, local environmental community data, waste, recycling, materials usage, wastewater, industry specific data, travel data, transport data, fuel efficiency data, environmental expenditure, noise pollution, environmental scoping, environmental incidents, and contaminated land, etc.	Hand-collected
GDI_REC_SOCIAL	=sum of sixteen graphical quality indicators of a social rectangular ESG graph (See Appendix A for detailed definition of each graphical quality indicator). Social graphs depict information about employee data, lost time and illness, work accidents, gender and racial equality, charitable activities, employee training spending, employee health and safety, corporate social responsibility outreach, and labor complaints, etc.	Hand-collected
GDI_REC_GOVERN	=sum of sixteen graphical quality indicators of a governance rectangular ESG graph (See Appendix A for detailed definition of each graphical quality indicator). Governance graphs depict information about data security, corporate social responsibility leadership, corporate social responsibility risks, corporate social responsibility management system, corporate social responsibility executive participation, etc.	Hand-collected
ESG_GDI_PIE	=sum of three graphical quality indicators of a pie ESG graph (See Appendix A for detailed definition of each graphical quality indicator). Increasing value of ESG_GDI denote lower quality of ESG graphs.	Hand-collected
GDI_PIE_ENVIORN	=sum of three graphical quality indicators of an environmental pie ESG graph (See Appendix A for detailed definition of each graphical quality indicator).	Hand-collected
GDI_PIE_SOCIAL	=sum of three graphical quality indicators of a social pie ESG graph (See Appendix A for detailed definition of each graphical quality indicator).	Hand-collected
GDI_PIE_GOVERN	=sum of three graphical quality indicators of a governance pie ESG graph (See Appendix A for detailed definition of each graphical quality indicator).	Hand-collected
POST	=1 if the fiscal year of the observation is bigger or equals to 2018, zero otherwise.	Hand-collected
ACCRUAL	==Absolute value of abnormal accruals, where abnormal accruals are obtained from the modified Jones (1991) model estimated by year and two-digit SIC code using those industries with at least 15 annual observations. Consistent with Kothari, Leone, and Wesley (2005), the model includes return on assets of year t-1 as a control for firm performance.	COMPUSTAT Global
SIZE	=natural log of total assets [AT] at the year t.	COMPUSTAT Global
LEV	=the long-term debt [DLTT] scaled by the total asset [AT] at year t.	COMPUSTAT Global
ROA	= income before extraordinary items [IB]/asset [AT] at year t	COMPUSTAT Global
SALE	=ln (SALE+1)	COMPUSTAT Global
CURRAT_RATIO	=current asset [ACT]/current liability [LCT] for year t	COMPUSTAT Global

GRAPH_COUNT	=the total number of ESG graphs in a single ESG report for firm i in year t	Hand-collected
LOSS	=an indicator variable set to one if the reports a loss [IB<0] during the year t and 0 otherwise.	COMPUSTAT Global
FINANCE	=an indicator variable that set to one if the number of shares outstanding [CSHO*AJEX] increased by at least 10% or long-term debt increased [DLTT+DD1] by at least 20% during the year and 0 otherwise.	COMPUSTAT Global
AR_IN	=accounts receivable and inventory [RECT + INVT]/total asset [AT] at year t	COMPUSTAT Global
CAPEXP	=capital spending [CAPX]/sales [SALE] for year t	COMPUSTAT Global
EARNVOL	=the standard deviation of ROA from year t-3 to year t	COMPUSTAT Global
BIG4	=1 if firm i's auditor in year t is one of the Big 4 auditors, zero otherwise.	COMPUSTAT Global
FUT_BHAR	=difference between firm i's buy and hold return, and the yearly market average buys and hold return in year t+1	COMPUSTAT Global - Security Daily
CHANGE_BHAR	=the difference between BHAR of year t and BHAR of year t-1	COMPUSTAT-Global - Security Daily
BHAR	=difference between firm i's buy and hold return and the yearly market average buys and hold return in year t	COMPUSTAT-Global - Security Daily
FUT_ILLIQUID	=natural log of the absolute value of stock price returns times 100 relative to the stock price times trading volume scaled by 1000 at year t+1: [Return*100]/(Price*Volume/1000)	COMPUSTAT-Global Security Daily
CHANGE_ILLIQUID	=the difference between ILLIQUID of year t and ILLIQUID of year t-1	COMPUSTAT-Global Security Daily
ILLIQUID	=natural log of the absolute value of stock price returns times 100 relative to the stock price times trading volume scaled by 1000 at year t: [Return*100]/(Price*Volume/1000)	COMPUSTAT-Global Security Daily
BTM	=the book value of the firm / the market value of the firm	COMPUSTAT Global
MKTBETA	=the coefficient on the market factor (b) from a linear regression of stock return of firm i (Ri) on the market return (Rm) for year t: Ri=a + b*Rm	COMPUSTAT-Global - Security Daily
RDEXP	=research and development costs [XRD]/total assets [AT] at year t	COMPUSTAT Global

TABLE 1
Sample Selection

	Num. of obs.
Europe top 100 public firms' ESG graph-year observations from 2016 to 2020	3554
Exclude: observations missing Compustat - Global information	-554
Sample used in the main analysis	3000
Exclude: observations missing control variable information in the moderation effect models	-1044
Sample used in the moderation effect analysis	1956

Table 2
Sample Statistics

Panel A - ESG graph quality and mandatory adoption regulation

variable	N	mean	sd	median	min	max
ESG_ GDI_REC	2067	3.9352	1.8401	4.0000	0.0000	9.0000
GDI_REC_ENVIORN	1,245	3.9398	1.9500	4.0000	0.0000	9.0000
GDI_REC_SOCIAL	745	3.8787	1.6713	4.0000	0.0000	9.0000
GDI_REC_GOVERN	77	4.3151	1.5624	4.0000	0.0000	7.0000
ESG_GDI_PIE	933	1.6663	0.8016	2.0000	0.0000	3.0000
GDI_PIE_ENVIORN	368	1.7290	0.7534	2.0000	0.0000	3.0000
GDI_PIE_SOCIAL	507	1.6381	0.8455	2.0000	0.0000	3.0000
GDI_PIE_GOVERN	58	1.5439	0.6832	2.0000	0.0000	3.0000
POST	3,000	0.6033	0.4653	1.0000	0.0000	1.0000
ACCRUAL	3,000	0.0352	0.0260	0.0303	0.0005	0.1319
SIZE	3,000	11.6108	1.5576	11.4692	8.2368	16.6439
LEV	3,000	0.1983	0.0843	0.1815	0.0000	0.4137
ROA	3,000	0.0262	0.0348	0.0298	-0.0869	0.1247
SALE	3,000	11.2649	1.4010	11.0095	8.5935	15.8994
CURRENT_RATIO	3,000	1.1325	0.2984	1.0959	0.5634	1.9238
GRAPH_COUNT	3,000	8.6760	22.681	2.0000	2.0000	56.000
LOSS	3,000	0.1513	0.3584	0.0000	0.0000	1.0000
FINANCE	3,000	0.3170	0.4654	0.0000	0.0000	1.0000
AR_IN	3,000	0.1969	0.0834	0.1776	0.0568	0.3834
CAPEXP	2,983	0.0846	0.0675	0.0650	0.0104	0.3329
EARNVOL	3,000	0.0199	0.0197	0.0128	0.0007	0.1034
BIG4	3,000	0.8540	0.3532	1.0000	0.0000	1.0000

Panel B - Moderation effect of mandatory adoption on ESG graph quality and market performance

variable	N	mean	sd	median	min	max
FUT_BHAR	1956	-0.0560	0.2699	-0.0646	-0.9276	1.2673
CHANGE_BHAR	1956	-0.0486	0.4301	-0.0085	-1.4839	1.4669
BHAR	1956	-0.0115	0.2916	-0.0646	-0.7808	1.2958
FUT_ILLIQUID	1956	0.0471	0.0610	0.0196	0.0000	0.3605
CHANGE_ILLIQUID	1956	0.0001	0.0445	0.0000	-0.3540	0.1269
ILLIQUID	1956	0.0458	0.0666	0.0168	0.0000	0.3690
ESG_GDI_REC	1956	3.9090	1.8426	4.0000	0.0000	9.0000
POST	1956	0.6897	0.4627	1.0000	0.0000	1.0000
SIZE	1956	11.7491	1.5575	11.6444	8.2368	16.6439
BTM	1956	0.4074	0.3890	0.3312	0.0103	1.7377
MKTBETA	1956	0.9329	0.3587	0.9844	0.1854	1.9456
LEV	1956	0.1900	0.0781	0.1756	0.0000	0.4137
FINANCE	1956	0.2894	0.4536	0.0000	0.0000	1.0000
ROA	1956	0.0281	0.0326	0.0303	-0.0869	0.1247
EARNVOL	1956	0.0200	0.0199	0.0126	0.0007	0.1034
RDEXP	1956	0.0128	0.0245	0.0018	0.0000	0.1200

Table 2- Panel A presents the sample statistics of variables used in H1 testing. Panel B presents the sample statistics for variables used in additional analyses. All variables are winsorized at 1st and 99th percentile. Please see Appendix B for detailed variable definitions.

Table 3
Pearson Correlation

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	*ESG_GDI_REC*	1.000							
(2)	*ESG_GDI_PIC*	-0.225	1.000						
(3)	*POST*	-0.083	0.030	1.000					
(4)	*ACCRUAL*	0.004	0.003	0.101	1.000				
(5)	*SIZE*	0.126	0.288	-0.005	-0.073	1.000			
(6)	*LEV*	0.010	-0.141	0.101	-0.100	0.106	1.000		
(7)	*ROA*	-0.026	0.077	0.014	-0.142	0.101	-0.283	1.000	
(8)	*SALE*	0.142	0.272	-0.013	-0.071	0.939	-0.027	0.162	1.000
(9)	*CURRENT_RATIO*	-0.026	0.199	0.030	0.025	0.206	-0.268	0.241	0.120
(10)	*GRAPH_COUNT*	-0.039	-0.145	-0.150	-0.216	0.061	0.023	-0.064	0.121
(11)	*LOSS*	0.035	-0.115	-0.003	0.270	-0.127	0.074	-0.722	-0.195
(12)	*FINANCE*	-0.143	0.051	0.010	0.160	-0.214	-0.188	-0.069	-0.149
(13)	*AR_IN*	0.004	-0.014	-0.036	-0.004	-0.323	-0.337	0.044	-0.164
(14)	*CAPEXP*	0.123	-0.081	-0.037	-0.124	0.407	0.382	-0.196	0.220
(15)	*EARNVOL*	0.142	-0.060	0.140	0.382	-0.202	-0.184	-0.148	-0.227
(16)	*BIG4*	-0.018	0.049	0.009	-0.110	-0.047	0.135	0.091	-0.084

		(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(9)	*CURRENT_RATIO*	1.000							
(10)	*GRAPH_COUNT*	-0.111	1.000						
(11)	*LOSS*	0.084	-0.060	1.000					
(12)	*FINANCE*	-0.095	0.035	0.044	1.000				
(13)	*AR_IN*	-0.003	-0.007	-0.109	0.081	1.000			
(14)	*CAPEXP*	0.049	0.105	0.159	-0.274	-0.617	1.000		
(15)	*EARNVOL*	0.180	-0.165	0.393	0.065	-0.117	0.025	1.000	
(16)	*BIG4*	0.185	-0.102	0.006	-0.187	0.016	-0.123	0.070	1.000

Table 4
The impact of CSR reporting mandate on ESG graph quality

	(1) *ESG_ GDI_REC*	(2) *ESG_GDI_PIE*
POST	**-0.397***	**-0.322*****
	(-1.86)	**(-2.94)**
ACCRUAL	2.150	-2.215
	(1.06)	(-1.61)
SIZE	0.561**	0.220
	(2.02)	(1.48)
LEV	-6.727***	-2.184***
	(-5.63)	(-3.89)
ROA	-9.587***	-8.851***
	(-3.37)	(-4.99)
SALE	-0.272	-0.094
	(-1.00)	(-0.65)
GRAPH_COUNT	-0.002	-0.002
	(-0.78)	(-0.76)
LOSS	-0.262	-0.464***
	(-1.24)	(-3.33)
FINANCE	0.330***	-0.032
	(2.70)	(-0.44)
AR_IN	2.273*	-1.823**
	(1.67)	(-2.33)
CAPEXP	3.123**	-1.607*
	(2.07)	(-1.93)
EARNVOL	17.698***	-2.309
	(4.37)	(-0.79)
BIG4	-0.650***	-0.021
	(-4.94)	(-0.20)
CONSTANT	2.147	1.303
	(1.12)	(1.33)
Industry fixed effects	YES	YES
Year fixed effects	YES	YES
Country fixed effects	YES	YES
N	2067	933
adj. R-sq	0.398	0.345

Table 4 presents the regression results of equation H1 – the impact of EU Directive on the quality of ESG graphs. The model specification is based on equation (3). The variable of interest is coefficient on POST. In column (1), the dependent variable in the OLS model is ESG_GDI_REC, the rectangular framework ESG graph distortion index. In column (2), the dependent variable is ESG_GDI_PIE, the pie ESG graph distortion index. We expect negative coefficients on POST in both columns. We include industry, year, and country fixed effects in each regression analysis. T-statistics are derived from Huber-White robust standard errors. The significance levels are based on two-tailed tests. *, **, *** Denote significance at p<0.1, p<0.05, and p<0.01, respectively. See Appendix B for all variable definitions. All continuous variables are winsorized at the 1% and 99% percentiles.

Table 5
The impact of CSR reporting mandate on the quality of rectangular environmental, social, and governance graphs

	(1) *GDI_REC_ENVIORN*	(2) *GDI_REC_SOCIAL*	(3) *GDI_REC_GOVERN*
POST	**-0.946*** **	**-1.013** **	-0.627
	(-3.96)	**(-2.17)**	(-0.56)
ACCRUAL	-1.306	4.952**	9.009
	(-0.45)	(1.97)	(0.59)
SIZE	0.296	-0.816***	-4.323**
	(1.14)	(-3.41)	(-2.33)
LEV	0.501	-0.911	-0.557
	(0.48)	(-0.55)	(-0.06)
ROA	-5.743	-13.269***	11.007
	(-1.64)	(-3.27)	(0.58)
SALE	0.116	1.001***	3.938
	(0.43)	(3.36)	(1.61)
SALE_GRW	-0.543	-0.518*	-10.433*
	(-1.36)	(-1.67)	(-1.70)
CURRENT_RATIO	-0.576*	0.739**	-0.100
	(-1.94)	(2.51)	(-0.10)
GRAPH_COUNT	0.002	-0.009***	-0.041
	(0.70)	(-3.60)	(-1.06)
LOSS	-0.432	-0.416	-3.703**
	(-1.29)	(-1.64)	(-2.13)
CAPEXP	5.038***	7.556***	22.772***
	(3.05)	(3.82)	(3.33)
EARNVOL	27.776***	19.388***	41.761
	(5.80)	(3.77)	(0.66)
CONSTANT	-1.132	2.416	7.592
	(-1.22)	(1.49)	(0.82)
Industry fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Country fixed effects	YES	YES	YES
N	1245	737	67
adj. R-sq	0.237	0.461	0.769

Table 5 presents the regression results of H1– the impact of EU reporting mandate on three categories of rectangular framework ESG graph quality. The model specification is based on equation (3). The variable of interest is coefficient on POST. The dependent variables in OLS models are environmental, social, and governance rectangular graph distortion indices (i.e., GDI_REC_ENVIORN, GDI_REC_SOCIAL, and GDI_REC_GOVERN). We expect negative coefficients on POST in all columns. We include the country, industry and year fixed effects in each regression analysis. T-statistics are derived from Huber-White robust standard errors. The significance levels are based on two-tailed tests. *, **, *** Denote significance at $p<0.1$, $p<0.05$, and $p<0.01$, respectively. See Appendix B for all variable definitions. All continuous variables are winsorized at the 1% and 99% percentiles.

Table 6
The impact of CSR reporting mandate on the quality of pie environmental, social, and governance graphs

	(1) *GDI_PIE_ENVIORN*	(2) *GDI_PIE_SOCIAL*	(3) *GDI_PIE_GOVERN*
POST	**-0.339****	**-0.389***	0.342
	(-2.51)	**(-1.87)**	(0.32)
ACCRUAL	-2.647	-5.033**	-4.747
	(-1.46)	(-2.37)	(-0.36)
SIZE	0.415**	0.271*	-1.479**
	(2.03)	(1.74)	(-2.45)
LEV	-0.488	-1.590**	-1.297
	(-0.63)	(-2.54)	(-0.26)
ROA	-6.158***	-11.701***	-54.868**
	(-2.72)	(-5.36)	(-2.51)
SALE	-0.498**	-0.150	1.534**
	(-2.17)	(-0.97)	(2.58)
SALE_GRW	0.540**	0.129	6.259*
	(2.41)	(0.48)	(1.70)
CURRENT_RATIO	0.320	0.124	-0.880
	(1.39)	(0.64)	(-0.64)
GRAPH_COUNT	0.000	-0.003	0.025***
	(0.05)	(-0.98)	(2.75)
LOSS	0.020	-0.500**	-1.783
	(0.11)	(-2.44)	(-1.54)
CAP_EXP	-1.801	-2.295*	-3.441
	(-1.10)	(-1.94)	(-1.07)
EARNVOL	-7.121*	-2.085	-44.753*
	(-1.86)	(-0.45)	(-1.76)
CONSTANT	3.064***	1.640**	10.608***
	(4.00)	(2.07)	(3.12)
Industry fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Country fixed effects	YES	YES	NO
N	366	506	57
adj. R-sq	0.307	0.387	0.414

Table 6 presents the regression results of H1 – the impact of EU reporting mandate on three categories of pie ESG graph quality. The model specification is based on equation (3). The variable of interest is coefficient on POST. The dependent variables in OLS models are environmental, social, and governance pie graph distortion indices (i.e., GDI_PIE_ENVIORN, GDI_PIE_SOCIAL, and GDI_PIE_GOVERN). We expect negative coefficients on POST in all columns. We include the country, industry, and year fixed effects in each regression analysis. T-statistics are derived from Huber-White robust standard errors. The significance levels are based on two-tailed tests. *, **, *** Denote significance at p<0.1, p<0.05, and p<0.01, respectively. See Appendix B for all variable definitions. All continuous variables are winsorized at the 1% and 99% percentiles.

Table 7 – Panel A
Sample Descriptive before and after Entropy Balancing

	Before Entropy Balancing					After Entropy Balancing		
	POST=1		*POST=0*		*POST=1*		*POST=0*	
Variable	mean	variance	mean	variance	mean	variance	mean	variance
ACCRUAL	0.036	0.001	0.031	0.000	0.036	0.001	0.036	0.001
SIZE	11.630	2.147	11.630	2.867	11.630	2.147	11.630	2.366
LEV	0.206	0.008	0.186	0.005	0.206	0.008	0.206	0.006
ROA	0.027	0.001	0.026	0.001	0.027	0.001	0.027	0.001
SALE	11.270	1.857	11.300	2.098	11.270	1.857	11.270	1.874
GRAPH_COUNT	26.47	440.40	33.77	639.70	26.47	440.40	26.47	446.60
LOSS	0.145	0.124	0.150	0.128	0.145	0.124	0.145	0.124
FINANCE	0.315	0.216	0.308	0.214	0.315	0.216	0.315	0.216
AR_IN	0.194	0.007	0.201	0.007	0.194	0.007	0.194	0.007
CAP	0.083	0.005	0.088	0.004	0.083	0.005	0.083	0.004
EARNVOL	0.021	0.000	0.016	0.000	0.021	0.000	0.021	0.001
BIG4	0.862	0.119	0.852	0.126	0.862	0.119	0.862	0.119

Table 7 -Panel B
The impact of CSR reporting mandate on ESG graph quality after entropy balancing

	(1)	(2)
	ESG_GDI_REC	*ESG_GDI_PIE*
POST	**-0.207****	**-0.279****
	(-2.21)	**(-2.30)**
Controls	YES	YES
Industry fixed effects	YES	YES
Year fixed effects	YES	YES
Country fixed effects	YES	YES
N	2057	933
adj. R-sq	0.131	0.373

Table 7 presents the estimation result of H1 based on entropy balanced sample. The model specification is based on equation (3). The variable of interest is POST. Panel A presents the sample statistics of regression variables between before and after entropy balancing. Panel B presents the regression results after entropy balancing. The dependent variables are ESG_GDI_REC and ESG_GDI_PIE, respectively. We expect negative coefficients on POST in both columns. We control for industry, year, and country fixed effects in each regression analysis. T-statistics are derived from Huber-White robust standard errors. The significance levels are based on two-tailed tests. *, **, *** Denote significance at p<0.1, p<0.05, and p<0.01, respectively. See Appendix B for all variable definitions. All continuous variables are winsorized at the 1% and 99% percentiles.

Table 8
Cross-sectional analyses of the impact of CSR reporting mandate on ESG graph quality

	(1) *ESG_GDI_REC* *HIGH_EPI=1*	(2) *ESG_GDI_REC* *HIGH_EPI=0*	(3) *ESG_GDI_REC* *HIGH_LEGAL=1*	(4) *ESG_GDI_REC* *HIGH_LEGAL=0*	(5) *ESG_GDI_REC* *HIGH_INCENT=1*	(6) *ESG_GDI_REC* *HIGH_INCENT=0*
POST	**-1.999*** **	**1.571*** **	**-0.591** **	-0.286	0.314	**-1.699*** **
	(-4.45)	**(3.21)**	**(-2.16)**	(-0.49)	(0.69)	**(-5.21)**
ACCRUAL	-6.911	6.070*	8.511***	-16.351***	-10.788**	12.712**
	(-1.58)	(1.89)	(3.44)	(-3.29)	(-2.12)	(2.25)
SIZE	0.030	-1.034	-0.711	-0.234	-0.061	2.853**
	(0.05)	(-1.37)	(-1.58)	(-0.42)	(-0.06)	(2.38)
LEV	3.917	-12.542***	-3.989**	2.332	-10.705**	-0.408
	(1.60)	(-8.32)	(-2.57)	(1.26)	(-2.32)	(-0.12)
ROA	-8.344	-3.300	-18.445***	-22.663***	-21.786***	8.309
	(-1.60)	(-0.58)	(-4.66)	(-3.17)	(-2.98)	(1.01)
SALE	0.410	3.880***	0.910*	0.635	1.817	-0.279
	(0.85)	(4.70)	(1.91)	(1.47)	(1.62)	(-0.23)
LOSS	-0.495**	1.265**	-1.764***	-0.629*	-1.057	-1.291***
	(-2.10)	(2.13)	(-5.10)	(-1.72)	(-1.50)	(-3.27)
FINANCE	0.596***	0.451**	-0.594***	0.457	1.508***	0.654**
	(3.17)	(1.99)	(-4.36)	(1.62)	(3.36)	(2.18)
AR_IN	7.401**	-18.175***	-1.093	6.197*	-13.033	7.118
	(2.09)	(-4.40)	(-0.39)	(1.96)	(-1.08)	(1.16)
CAPEXP	-4.151	13.733***	1.364	4.566**	12.331*	17.935*
	(-1.29)	(5.65)	(0.35)	(2.32)	(1.67)	(1.96)
EARNVOL	16.927**	-12.942*	8.754	61.626***	23.213**	38.664***
	(2.29)	(-1.74)	(1.45)	(8.50)	(2.19)	(3.49)
BIG4	-1.024	0.185	-2.596***	-0.378*	0.000	2.265***
	(-1.39)	(0.72)	(-5.69)	(-1.93)	(.)	(2.75)
EPI	-0.215***	0.067				
	(-4.95)	(1.53)				
LSI			-0.052	-0.634***		
			(-0.32)	(-10.58)		
STOCK_INCENT					-0.000	-0.000**

					(-0.23)	(-2.53)
Industry fixed effects	YES	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES	YES
CONSTANT	19.520***	-18.929***	6.906***	2.352	-10.500***	-36.567***
	(3.65)	(-3.22)	(4.42)	(0.92)	(-2.83)	(-4.62)
N	1059	998	1153	904	493	589
adj. R-sq	0.433	0.521	0.317	0.438	0.584	0.475

Table 8 presents three cross-sectional analyses of H1. The dependent variables in all columns are ESG_GDI_REC and independent variables are POST. Columns (1) and (2) present the cross-sectional analysis of H1 based on EU member countries' environmental performance index. Column (1) shows the regression result based on a subsample of firms that locate in EU countries that have higher than sample average of environmental performance index (HIGH_EPI=1). Column (2) shows the result based on a subsample of firms that locate in EU countries that have lower than sample average of environmental performance index (HIGH_EPI=0). We expect a significant negative coefficient on POST in column (1) but not in column (2). Column (3) shows result based on a subsample of firms that have higher than average business regulatory strength rating (HIGH_LEGAL=1). Column (4) shows the result based on a subsample of firms that have lower than average business regulatory strength rating (HIGH_LEGAL=0). We expect a significant negative coefficient on POST in column (3) but not in column (4). Column (5) presents the result based on a subsample of firms that executives' equity compensation is higher than average (HIGH_INCENT=1) and column (6) presents the result based on a subsample of firms that executive equity compensation is lower than average (HIGH_INCENT=0). We expect a significant negative coefficient on POST in column (6) but not in column (5). We control for industry, year, and country fixed effects in each regression analysis. T-statistics are derived from Huber-White robust standard errors. The significance levels are based on two-tailed tests. *, **, *** Denote significance at $p<0.1$, $p<0.05$, and $p<0.01$, respectively. See Appendix B for all variable definitions. All continuous variables are winsorized at the 1% and 99% percentiles.

Table 9
The moderation effect of CSR reporting mandate on the relationship between ESG graph quality and long-term market performance

	(1) *FUT_BHAR*	(2) *CHANGE_BHAR*	(3) *FUT_BHAR*
ESG_GDI_REC	**-0.019*** **	**-0.023*** **	-0.026***
	(-4.13)	**(-3.25)**	(-4.96)
POST			0.075*
			(1.91)
*ESG_GDI_REC*POST*			**-0.042*** **
			(-6.18)
SIZE	-0.039**	-0.076***	-0.011
	(-2.10)	(-2.62)	(-0.58)
BTM	0.175***	0.267***	-0.057***
	(6.94)	(6.68)	(-2.79)
MKTBETA	-0.193***	-0.517***	0.250***
	(-5.18)	(-7.64)	(5.85)
LEV	0.132	0.067	-0.271
	(0.59)	(0.22)	(-1.32)
FINANCE	-0.017	0.010	-0.004
	(-0.75)	(0.27)	(-0.23)
ROA	0.110	-0.805	0.774**
	(0.26)	(-1.45)	(2.19)
EARNVOL	0.431	2.540**	-2.034***
	(0.53)	(2.30)	(-3.27)
RDEXP	0.923	-1.605	2.437***
	(1.12)	(-1.31)	(3.24)
ILLIQUID	1.550***	1.342***	0.018
	(7.44)	(4.25)	(0.09)
CONSTANT	0.295	0.328	0.657**
	(1.14)	(0.72)	(2.01)
Industry fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Country fixed effects	YES	YES	YES
N	1956	1956	1956
adj. R-sq	0.323	0.325	0.332

Table 9 presents the regression result of the moderation effect of CSR reporting mandate on the relationship between ESG graph quality and one year buy and hold abnormal return. In column (1) the dependent variable is buy and hold abnormal return at year t+1 (FUT_BHAR). The study of interest is ESG_GDI_REC. We expect a negative coefficient on ESG_GDI_REC. In column (2) the dependent variable is the change of one year buy and hold return from year t to year t-1 (CHANGE_BHAR). The study of interest is ESG_GDI_REC. We expect a negative coefficient on ESG_GDI_REC. In column (3), the dependent variable is FUT_BHAR. The study of interest is the interaction ESG_GDI_REC*POST. We expect a negative coefficient on the interaction term. We control for industry, year, and country fixed effects in each regression analysis. T-statistics are derived from Huber-White robust standard errors. The significance levels are based on two-tailed tests. *, **, *** Denote significance at p<0.1, p<0.05, and p<0.01, respectively. See Appendix B for all variable definitions. All continuous variables are winsorized at the 1% and 99% percentiles.

Table 10
The moderation effect of mandatory adoption on the relationship between ESG graph quality and financial performance

	(1) *FUT_ROA*	(2) *CHANGE_ROA*	(3) *FUT_ROA*
ESG_GDI_REC	**-0.001***** **(-3.21)**	**-0.001***** **(-3.35)**	-0.0005 (0.17)
POST			0.004 (1.23)
*ESG_GDI_REC*POST*			**-0.001***** **(-3.31)**
SIZE	-0.023*** (-8.03)	-0.005 (-1.26)	-0.024*** (-8.22)
LEV	-0.044*** (-3.44)	0.128*** (6.71)	-0.041*** (-3.14)
SALE	0.015*** (5.50)	0.012*** (3.22)	0.015*** (5.77)
LOSS	-0.045*** (-23.19)	0.034*** (10.55)	-0.045*** (-23.20)
SALE_GRW	0.028*** (10.49)	0.003 (0.44)	0.028*** (10.54)
AR_IN	-0.102*** (-7.26)	0.067*** (3.12)	-0.103*** (-7.27)
CAPEXP	0.105*** (4.86)	0.048 (1.57)	0.112*** (5.03)
BIG4	-0.002 (-1.32)	-0.001 (-0.74)	-0.002 (-1.26)
GRAPH_COUNT	0.000** (2.13)	0.000*** (3.66)	0.000** (1.99)
CONSTANT	0.181*** (9.04)	-0.134*** (-5.05)	0.180*** (9.04)
Industry fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Country fixed effects	YES	YES	YES
N	1956	1956	1956
adj. R-sq	0.843	0.452	0.840

Table 10 presents the regression result of the moderation effect of CSR reporting mandate on the relationship between ESG graph quality and return on asset. In column (1) the dependent variable is return on asset at year t+1 (FUT_ROA). The study of interest is *ESG_GDI_REC*. We expect a negative coefficient on *ESG_GDI_REC*. In column (2) the dependent variable is the change of ROA from year t to year t-1 (CHANGE_ROA). The study of interest is ESG_GDI_REC. We expect a negative coefficient on ESG_GDI_REC. In column (3), the dependent variable is FUT_ROA. The study of interest is the interaction ESG_GDI_REC*POST. We expect a negative coefficient on the interaction term. We control for industry, year, and country fixed effects in each regression analysis. T-statistics are derived from Huber-White robust standard errors. The significance levels are based on two-tailed tests. *, **, *** Denote significance at p<0.1, p<0.05, and p<0.01, respectively. See Appendix B for all variable definitions. All continuous variables are winsorized at the 1% and 99% percentiles.

Table 11
The moderation effect of mandatory adoption on the relationship between ESG graph quality and market liquidity

	(1) *FUT_ILLIQUID*	(2) *CHANGE_ILLIQUID*	(3) *FUT_ILLIQUID*
ESG_GDI_REC	**0.002*** **	**0.002*** **	0.001
	(3.67)	**(4.59)**	(1.15)
POST			-0.017***
			(-3.00)
*ESG_GDI_REC*POST*			**0.002***
			(1.85)
SIZE	0.025***	0.007***	0.023***
	(7.80)	(3.34)	(7.62)
BTM	0.018***	0.016***	-0.002
	(3.08)	(3.98)	(-0.58)
MKTBETA	-0.043***	-0.007*	-0.029***
	(-7.50)	(-1.88)	(-5.65)
GRAPH_COUNT	0.001***	0.000	0.001***
	(6.99)	(0.15)	(7.79)
LEV	-0.247***	-0.052*	-0.164***
	(-7.34)	(-1.65)	(-5.25)
FINANCE	0.023***	-0.002	0.022***
	(6.49)	(-0.83)	(6.44)
ROA	-0.242***	0.056	-0.339***
	(-4.36)	(0.74)	(-5.04)
EARNVOL	0.439***	-0.103	0.613***
	(3.13)	(-1.41)	(5.41)
RDEXP	0.060	0.472***	-0.556***
	(0.34)	(5.07)	(-3.93)
CONSTANT	-0.155***	-0.129***	-0.098**
	(-3.69)	(-4.69)	(-2.42)
Industry fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Country fixed effects	YES	YES	YES
N	1956	1956	1956
adj. R-sq	0.638	0.534	0.772

Table 11 presents the regression result of the moderation effect of CSR reporting mandate on the relationship between ESG graph quality and the market illiquidity. In column (1) the dependent variable is market illiquidity at year t+1 (FUT_ILLIQUID). The study of interest is *ESG_GDI_REC*. We expect a positive coefficient on *ESG_GDI_REC*. In column (2) the dependent variable is the change of the market illiquidity from year t to year t-1 (CHANGE_ILLIQUID). The study of interest is ESG_GDI_REC. We expect a positive coefficient on ESG_GDI_REC. In column (3), the dependent variable is FUT_ILLIQUID. The study of interest is the interaction ESG_GDI_REC*POST. We expect a positive coefficient on the interaction term. We control for industry, year, and country fixed effects in each regression analysis. T-statistics are derived from Huber-White robust standard errors. The significance levels are based on two-tailed tests. *, **, *** Denote significance at p<0.1, p<0.05, and p<0.01, respectively. See Appendix B for all variable definitions. All continuous variables are winsorized at the 1% and 99% percentiles.