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Mandatory R&D disclosure and analyst forecast Accuracy: Evidence from an emerging market ☆

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ABSTRACT

Exploiting the mandatory R&D disclosure policy in China, we capitalize on a difference-in-differences framework to examine whether mandatory R&D disclosure matters to analyst forecast accuracy in a sample of technology intensive firms. We find that, after mandatory R&D disclosure, forecast errors decrease significantly more for treatment firms (i.e., firms that chose not to disclose R&D investments before the mandate policy) relative to control firms (i.e., firms that did voluntary disclosure of R&D investments before the mandate policy). Further, we show that the impact of mandatory R&D disclosure is more pronounced when there is high information asymmetry within the firm or an industry as well as when analysts are working under unfavorable conditions. Overall, our findings demonstrate the positive effect of mandatory R&D disclosure on reducing information asymmetry and shed light on the importance of R&D disclosure reform in developing markets.

1. Introduction

Research and development (R&D) investments have grown rapidly over the last decade as they closely pertain to the long-term competitiveness for many firms, especially those in science and technology-intensive industries. Meanwhile, R&D investments manifest some remarkable distinctions from other physical assets (Aboody and Lev, 2000). First, R&D investments are unique to each firm. That is, individual firms have their own unique R&D investments, whereas other financial inputs (e.g., fixed asset or inventory) may share similarities within the same industry. Second, under current accounting principles, R&D spending is expensed immediately rather than capitalized in financial statements. Such treatment makes it hard for investors to derive information regarding the productivity and value of R&D investments. Lastly, R&D projects may fail. Normally, a prolonged period of R&D spending is required to realize such project's future economic benefits.

Owing to the significance as well as the associated feature of R&D investments, the Chinese Security Regulatory Commission (CSRC) revised the requirements on the content and formats of annual report in December 2012, in which mandated listed firms with R&D investments to disclose detailed R&D information in the Management Discussion and Analysis (MD&A) section of annual report. As expected by regulators, this move can make firms' proprietary R&D information public

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to market participants and reduce information asymmetry on R&D projects. Regarding the effect of such mandatory disclosure on information environment and thus market participants' behavior, however, academic evidence is relatively scarce. Existing literature mainly focuses on voluntary R&D disclosure and discusses its economic consequences (e.g., Jones, 2007; Merkley, 2014). To fill in this gap, this study investigates whether mandatory R&D disclosure matters to stakeholders with a focus on securities analysts and their earnings forecast accuracy in China.

We have particular reason to focus on securities analysts. Securities analysts are viewed as one of the most important financial statement users (Bae et al., 2008). Usually, analysts harness information disclosed by the firm into their forecast models when making earnings forecast (Barker and Imam, 2008). The accuracy of analyst' earnings forecast somewhat captures the information quality of earnings reports (Francis et al., 2002). In this sense, examinations of analyst behavior around mandatory R&D disclosure allow us to ascertain the role of the R&D mandate in the informativeness of financial statements, and more concretely, in the earnings quality.

Previous literature argues that R&D investments act as a potential driver of information asymmetry between firms and information users (Aboody and Lev, 2000). The extent of such asymmetry somewhat depends on a firm's disclosure behavior. In the case of mandatory R&D disclosure, firm can choose to behave in accordance with either the well implementation or biased implementation. if firms rigorously comply with the mandatory R&D disclosure, information users can obtain relevant and material information on R&D projects. Clearly, the enhanced transparency on R&D projects benefits analysts because it facilitates analysts' information process and curtails uncertainty around an earnings forecast (Hope, 2003). Along this line of reasoning, we expect that analyst can issue more accurate earnings forecast with the help of mandatory R&D disclosure.

At the presumption of mandatory disclosure, firms may also put discretion in implementation, leading to the biased implementation (Muller et al., 2011; Byard et al., 2011). This is because comprehensive R&D reporting is also favorable to potential competitors and spurs firms to incur proprietary costs (Botosan and Stanford, 2005). To reduce such cost, firms prefer to provide non-material or non-informative R&D information. This discretion on information disclosure, undoubtedly, makes information asymmetry become worse and keeps analysts from incorporating useful information into their expectation. With this line of argument, analyst forecasts are expected to be less precise despite the imposition of the R&D disclosure mandate.

Following the preceding discussion, the impact of mandatory R&D disclosure on analyst forecast accuracy remains ambiguous. Akin to Huang et al. (2023), we capitalize on the DID framework to unravel this research question. To make the test executable, we construct a control (treatment) sample covering technology-intensive firms that always (never) disclosed R&D investments during the three-year pre-mandate period. We focus on technology-intensive firms because these firms theoretically all make R&D investments and R&D information is a vital information source for analysts to issue precise earnings forecasts. Overall, we find that mandatory R&D disclosure contributes to analyst forecast accuracy. Put differently, forecast errors dwindle for mandatory disclosers (i.e., firms that previously chose not to disclose R&D investments) compared to voluntary disclosers (i.e., firms that previously did voluntary disclosure of R&D investments). Moreover, the impact of the R&D disclosure mandate is more pronounced for firms with higher levels of information asymmetry, firms operating in industry with poor information environment, or firms with analysts working under adverse conditions. In addition, our conclusion holds for various robustness checks about the sample bias, variable construction, and estimation procedure. Together, these findings suggest that mandatory R&D disclosure attenuates information asymmetry, which enables analysts to better incorporate detailed R&D information in projections and consequently improves analyst forecast accuracy.

We contribute to the existing literature in several ways. First, this study looks into the economic consequences of mandatory R&D disclosure in terms of analyst forecast and unveils that mandatory R&D disclosure adopters experience a significant amelioration in the information environment for financial analysts. This finding complements Huang et al. (2023) who probes the unintended effect of mandatory R&D disclosure on innovation. Meanwhile, this finding provides evidence for the argument in previous studies that mandatory disclosure is conducive to increasing information available to information users (e.g., Berger and Hann, 2003; Kong et al., 2022; Campbell et al., 2021; Hu et al., 2022; Byard et al., 2011; Horton et al., 2013).

Second, earlier work has extensively examined how various disclosure features affect analyst forecast property. For example, analyst forecast accuracy improves when a firm complies with U.S. Security and Exchange Commission (SEC) guidelines on MD&A (Barron et al., 1999), gains a high rating on financial statements (Hope, 2003), makes more forward-looking disclosure (Bozzolan et al., 2009), publishes corporate responsibility reports (Dhaliwal et al., 2012), adopts International Financial Reporting Standards (Horton et al., 2013), employs the eXtensible Business Reporting Language (XBRL) (Liu et al., 2014), makes corporate governance transparent (Bhat et al., 2006), IFRS adoption (Chen et al., 2021), and issues internal control reports (Ji et al., 2019). Our findings emphasize that mandatory R&D disclosure is an equally important driving force for increased analyst forecast accuracy, thereby enriching this stream of literature. Moreover, our findings add to the literature that examines whether analysts acquire and properly account for R&D related information when making earnings forecasts (For example, He and Tian 2013; Beyhaghi et al., 2023; Cheng et al. 2022, Tan et al., 2019).

Finally, this study wades into the debate surrounding whether R&D disclosure should be mandated. Given the salutary effect that the R&D mandate has in China, these results yield pivotal insights for policymakers in other emerging countries when mulling a similar reform in their capital markets. Our findings allow watchdogs to go one step forward in deciding how to report R&D investments under the mandatory regime.

The rest of the study proceeds as follows. Section 2 discusses the institutional background, while Section 3 develops testable hypotheses after reviewing previous literature. Section 4 presents the sample selection and research design. Section 5 summarizes our findings after empirical analyses and the conclusion follows in Section 6.

2. Institutional background

Several studies indicate that firms benefit substantially from R&D investments, which may bring about technological innovation (Belderbos et al., 2004). To gain worldwide competitiveness, the Chinese government has advocated that manufacturing sectors attach great importance to R&D. Long-run economic growth in China may hinge on its ability to attain the technological breakthrough (Guo, 2008). Consequently, Chinese policymakers have rolled out several R&D initiatives in recent years. One of the major reforms is the mandatory R&D disclosure. Specifically, the CSRC revised the "*Standards Concerning the Content and Formats of Information Disclosure by Companies Offering Securities to the Public No. 2--Contents and Formats of Annual Reports*[1]" in December 2012, wherein firms with R&D investments are mandated to disclose detailed R&D information in the Management Discussion and Analysis (MD&A) section of annual report. Three points in this revision are worth notice here. One, the CSRC mainly enforces this revision on firms with R&D investments, consisting of firms in new industries, firms using new technologies, and firms running on new business models. Two, both financial and non-financial R&D information are required to be disclosed, including investment amount as well as the purposes, progress, target, and expected impact of ongoing R&D activities. For the non-financial R&D information, this revision does not set clear disclosure standard due to the unique nature of R&D activities information. This, in fact, allows firms to apply discretion when implementing the mandatory R&D disclosure policy. Three, this revision began for firms from the annual reports for fiscal year 2012, given that listed firms should disclose the annual report within four months from the end of each fiscal year. For the implementation, most firms disclose financial R&D information in accordance with the mandate. This is confirmed by Huang et al. (2023) who show there was a significant increase of the number of firms disclosing R&D expenditure in and after 2012. However, for the disclosure of non-financial R&D information, there exists variation of implementation across firms. Appendix A provides four examples to illustrate such variation.

Overall, this institutional reform establishes a unique setting where we can contrast changes in forecast accuracy for mandatory R&D disclosers with voluntary disclosers after 2012.

3. Literature review and hypothesis development

3.1. Literature on R&D disclosure

Vast literature concentrates on the performance and valuation of R&D activities. For instance, R&D projects are found to exert an influence on firm performance and future cash flow (Lev, 2001). Because they are too firm-specific, R&D activities tend to be a source of uncertain information (Aboody and Lev, 2000; Kothari et al., 2002). Apart from this, long-term values of R&D investments are likely underestimated in that the generally accepted accounting principle requires recognizing R&D expenditures immediately. As a whole, these studies point out the presence of R&D-driven information asymmetry between corporate insiders and outsiders.

Despite the informational role of R&D, its disclosure is not mandated by accounting standards in many countries. In most cases, the firm voluntarily releases R&D information via financial statements due to two motives. The first one stems from the demand-side argument that more R&D disclosure is provided to satisfy investors' need for value-relevant information. This idea is echoed by a large body of work exploring how R&D disclosure helps investors gain a better understanding of a firm's operation. For example, Entwistle (1999) discovers that the amount of disclosed R&D depends on three environmental factors: R&D investments, listing status, and industry affiliation. Furthermore, Guo et al. (2004) show that greater R&D reporting is associated with lower information asymmetry, while Jones (2007) demonstrates that market participants benefit from financial disclosures in alleviating the uncertainty around R&D activities. Based on content analysis, Merkley (2014) reports evidence that narrative R&D disclosure conveys useful information.

The second motive emanates from the managerial-manipulation view that firms adjust R&D disclosure to avoid proprietary costs and obfuscate performance information. Referring to many theoretical models (Verrecchia, 1983), inside information would be withheld if the proprietary cost from publishing the information surpasses the incremental value of its release. Regarding R&D, detailed disclosure lets product market competitors access the firm's specific knowledge, which inevitably undermines the first-mover advantage (Segerstrom, 1991). Hence, managers may either distort R&D disclosure (Newman and Sansing, 1993) or make uninformed disclosure (Gigler, 1994) to mislead potential competitors. As suggested by the earnings management literature (Guttman et al., 2006; Einhorn and Ziv, 2012), firms presumably leverage the complexity involved with R&D investments to downplay poor performance. When managers encounter worse-than-expected earnings, they have incentives to distract investors' attention by making vague R&D disclosures (Merkley, 2014). For example, patent disclosures occur frequently amid lower earnings (Lansford, 2006), while managers tweak the tone of R&D reporting to spin

[1] https://www.csrc.gov.cn/csrc_en/c102034/c1371384/content.shtml (accessed February 26, 2023).

earnings news (Li, 2010). Collectively, the second motive implies that R&D disclosure provides irrelevant rather than relevant information to the users.

Whatever the motive, researchers argue that voluntary disclosure appears to be inadequate to resolve the information asymmetry problem as: a) disclosed information is unaudited, and b) financial statement users find it costly to identify value-relevant information (Anton and Yao, 2002). To improve the R&D information environment, as stated before, China mandated firms with R&D investments to disclose R&D information in 2012. Utilizing such policy shock, Huang et al. (2023) firstly examine the economic consequences of mandatory R&D disclosure. They find that the mandatory R&D disclosure has unintended knock-on effects, leading firms to digress from their long-term innovation strategies to shortsighted innovation schemes. Except for this, there is lack of studies investigating the effect of mandatory R&D disclosure on information environment. With the existence of the mandatory disclosure, firms do not have discretion on whether to disclose information but on how to provide information. Expected by the policymakers, firms should disclose material or informative information in accordance with the mandate, resulting in an increase in comparability as well as information set available (Horton et al., 2013). This is indeed the case in many settings (e.g., Berger and Hann, 2003; Kong et al., 2022; Campbell et al., 2021; Hu et al., 2022; Byard et al., 2011; Horton et al., 2013). Meanwhile, it also common for the variation in implementation of mandatory disclosure across firms. For this reason, some researchers contend that the mandatory disclosure is insufficient to reduce information asymmetry (Muller et al., 2011; Byard et al., 2011). Extending this debate to the setting of R&D information, we explore how the mandatory disclosure policy exerts its effect on firms' information environment.

3.2. Literature on analyst forecast

Considering Schipper (1991), an analyst's duty is to render earnings forecasts and investment advices to investors concerned. To make a reliable inference, analysts are accustomed to obtaining vital information sourced from annual reports (Miles and Nobes, 1998). Provided extensive professional knowledge and superior information-processing capacities, researchers consider analysts as sophisticated users of financial statements (Bae et al., 2008).

Several theoretical studies indicate that quality disclosure is conducive to resolving information asymmetry between managers and analysts (Lambert et al., 2007). That is, the more relevant and useful information released by financial statements, the more precise the earnings forecast issued by analysts. Daske et al. (2008) interpret the enhanced analyst forecast accuracy as firms refraining from engaging in opportunistic earnings management for better information disclosure.

Empirically, numerous earlier studies scrutinize the impact of disclosure on analyst forecast accuracy. For example, Lang and Lundholm (1996) find that overall reporting quality is positively associated with analyst forecast accuracy in the U.S. Using a global sample, Hope (2003) finds that earnings reports with a higher Center for International Financial Analysis and Research (CIFAR) rating led to more accurate future earnings per share (EPS) predictions by analysts. Analyst forecast errors tend to decline if a firm complies with SEC guidelines on MD&A (Barron et al., 1999), provides more forward-looking disclosure (Bozzolan et al., 2009), issues the corporate social responsibility report (Dhaliwal et al., 2012), adopts the International Financial Reporting Standards (Horton et al., 2013), employs the eXtensible Business Reporting Language (XBRL) (Liu et al., 2014), use less tax planning (Francis et al., 2019), coverage change of analysts (Cheong et al., 2019), releases the internal control report (Ji et al., 2019), and in the presence of short selling (Hou et al., 2021).

Similar to our work, there are three studies examining whether R&D-related activity affects analyst forecast accuracy. Amir et al. (2003) demonstrate a positive relation between forecast errors and capitalization of R&D. Gu and Wang (2005) illustrate that forecast errors are positively associated with R&D investments. Recently, Hill et al. (2019) attribute less accurate forecasts to the overestimation of R&D investments. However, unlike these studies of not using mandatory disclosure, we specifically examine the impact of mandatory R&D disclosure on analyst forecast accuracy.

3.3. Hypothesis development

Pursuant to prior literature on mandatory information disclosure, we develop our testable hypotheses from the perspectives of well implementation and biased implementation. As Aboody and Lev (2000) argue, R&D activities are embroiled in tremendous information asymmetry, complexity, and uncertainty. A lack of R&D disclosure unavoidably puts information users at a disadvantaged position (Guo et al., 2004). Given the importance of R&D information, the primary goal of mandatory R&D disclosure was to direct firms to provide relevant and useful information on R&D projects and thus reduce the information asymmetry on R&D projects. If the mandatory R&D disclosure is well implemented by firms, users' demand for more information can be fully met. This naturally benefits analysts that are one of the financial report users. Specifically, with access to better R&D information, analysts can yield more insight into a firm's operation (Entwistle, 1999; Jones, 2007; Merkley, 2014) and thus arrive at more accurate earnings estimates (Hope, 2003). Therefore, we expect analyst forecast accuracy to increase for firms subject to mandatory R&D disclosure and formulate the first testable hypothesis as follows:

H1a: Mandatory R&D disclosure is positively associated with analyst forecast accuracy.

Given information disclosure requirements, biased implementation also may arise due to the existence of managerial discretion (Muller et al., 2011; Byard et al., 2011). Prior literature suggests that R&D information is proprietary (Boone et al.,

2016) and disclosing such information makes firms' strategies on R&D projects exposed to product market competitors (Botosan and Stanford, 2005). For firms, detailed R&D disclosure may incur proprietary costs. To reduce such costs, firms are willing to manipulate R&D disclosure. This willingness brings biased implementation in the case of mandatory R&D disclosure. In concrete term, firms may release non-material or non-informative R&D information to meet the requirement. This applies to our setting because the mandatory policy allows managerial discretion on the R&D disclosure and there are differences in the level of enforcement in different regions. As a result, the discretionary implementation of mandatory R&D disclosure renders R&D information less informative, which aggravates information asymmetry on R&D projects and thus hampers analysts make accurate forecasts. Consistent with these arguments, we expect that analyst forecast accuracy may decrease for firms required to disclose R&D information and formulate our second hypothesis as follows.

H1b: Mandatory R&D disclosure is negatively associated with analyst forecast accuracy.

4. Sample and research design

4.1. Sample selection

Our data are retrieved from the China Stock Market and Accounting Research (CSMAR) database. Since the mandate was implemented in January 2013, any applicable R&D information had to be disclosed in the annual report for fiscal year 2012. To fit the ensuing DID model design, we set the sample period from 2009 to 2014 where 2009–2011 (2012–2014) are coded as the pre-mandate (post-mandate) period. On top of this, we restrict the initial sample to listed firms from technology-intensive sectors[2], which are more likely to engage in R&D investments. By doing so, we can ensure that 1) our sample firms make R&D investments but have difference in their disclosure behavior, thereby leaving out the possibility that firms do not disclose R&D information because they do not have R&D investments; 2) firms' R&D information do matter in analysts' earnings forecasts. Next, we screen the sample by deleting: a) firms without analysts following them; b) firms with financial irregularity; c) firms without available data in the pre-mandate and post-mandate periods; d) firms in the ChiNext market[3]; and e) firms with missing financial records. Our final sample amounts to 2,171 year-firm observations. We present the sample selection process in Panel A of Table 1. In Panel B, we present the frequency distribution of the sample by year. During 2009 to 2014, the yearly frequency is quite even. For the frequency distribution by industry, computer and telecommunication industry has the large number of firms.

Research design

To evaluate the testable hypotheses, referring to Huang et al. (2023), we apply the DID framework to ascertain whether mandatory R&D disclosure increases or decreases forecast errors, an inverse measure of analyst forecast accuracy. Following Byard et al. (2011), we first capture the effect of concurrent confounding events with voluntary disclosers as our control sample. As R&D activity is reported by voluntary disclosers surrounding the mandate in 2012, the impact of the mandatory R&D disclosure has minimal effect on these firms. Thus, any changes in forecast errors for these voluntary disclosure firms presumably represent the impact of concurrent economic and regulatory variations instead of the impact of R&D disclosure reform. Next, we examine the differences in forecast errors between mandatory and voluntary disclosers three years before and after the implementation date. The following baseline DID regression is specified to investigate the role of mandatory R&D disclosure on analyst earnings forecast accuracy.

$$\begin{aligned} Accuracy_{it} = {} & \beta_0 + \beta_1 Post_t + \beta_2 Post_t * Treat_i + \beta_3 Size_{it} + \beta_4 Lev_{it} + \beta_5 Roe_{it} + \beta_6 Growth_{it} + \beta_7 PPE_{it} + \beta_8 EPS_{it} \\ & + \beta_9 Ret_{it} + \beta_{10} R\&DDetail_{it} + \beta_{11} R\&DExpense + \beta_{12} Patent_{it} + \beta_{13} Follow_{it} + \beta_{14} GDP_{it} + Industry + Firm \\ & + Year + \varepsilon_{it} \end{aligned} \quad (1)$$

where $Accuracy_{it}$ represents firm *i*'s forecast error in year *t*, which is defined as the absolute difference between actual earnings and consensus forecast, scaled by the beginning-of-the-year stock price. Consensus forecast is the median of earnings predictions issued by analysts for the first time within 30 days after the earnings announcement of year *t-1*. $Post_t$ is an indicator variable taking the value of 1 in the post-mandate periods (years 2012, 2013, and 2014) and zero otherwise.[4] $Treat_i$ is an indicator variable taking the value of 1 (0) if firm *i* never (always) reports the R&D expense in the pre-mandate period. Based on the above specification, the interaction term (*Post*Treat*) captures the change in forecast errors for treatment firms (those had R&D investments but did not disclose R&D before the mandate) after the mandate compared to the change for control firms (those had R&D investments and disclosed R&D before the mandate), which is identical to the impact of mandatory R&D dis-

[2] According to National Bureau of Statistics in China, technology-intense sectors encompass pharmacy, common equipment, specialized equipment, transportation equipment, electrical machinery, computer, telecommunication, meter, and information technology.

[3] In China, the information disclosures of firms in the Growth Enterprises Market need to conform to another policy, namely "*the Standards concerning the Contents and Formats of Information Disclosure by Companies Offering Securities to the Public No. 30 –Contents and Formats of Annual Reports of Companies Listed on the Growth Enterprise Market*".

[4] The policy took effect as of January 1, 2013. Hence, the financial statements prepared in early 2013 (i.e., for accounting year 2012) needs to incorporate the policy change. Thus, we take 2012, 2013, and 2014 as post-mandate periods. The results are qualitatively the same if we remove 2012 sample years.

Table 1
Sample Selection and Distribution.

Panel A: Sample Selection	
Firms listed (non-financial) from 2009 to 2014	15,522
Excluded:	
Firms in the ChiNext market	(2137)
Firms who are not in the technology-intensive sectors	(9136)
Firms without analysts following them	(1844)
Firms with financial irregularity	(6)
Firms who are designated as ST or PT	(18)
Firms with missing variables	(210)
Final sample	2171

Panel B: Sample distribution by year

	#firm-years	#Treatment Firms (*Treat* = 1)	#Control Firms (*Treat* = 0)
2009	364	214	150
2010	413	205	208
2011	420	190	230
2012	316	135	181
2013	324	153	171
2014	334	160	174
Total	2171	1057	1114

Panel C: Sample distribution by industry

	#firm-years	#Treatment Firms (*Treat* = 1)	#Control Firms (*Treat* = 0)
Pharmacy	398	213	185
Common Equipment	207	106	101
Specialized Equipment	252	108	144
Transportation Equipment	298	168	130
Electrical Machinery	309	171	138
Computer and Telecommunication	476	193	283
Meter	14	7	7
Information Technology	217	91	126
Total	2171	1057	1114

Note: This table presents the sample selection (in Panel A) and frequency distribution of the sample by year and industry.

closure on forecast errors. If H1a (H1b) is valid, we expect β_2 to be significantly negative (positive). Our DID research design is similar to that in Cho (2015) for the impact of SFAS No. 131 on internal capital market efficiency. Once control for firm and year fixed effects, there is no need to use *Treat* as a standalone explanatory variable in Eq. (1).

According to previous literature (Hope, 2003; Byard et al., 2011; Demmer et al., 2019), we include several control variables that possibly affect analyst forecast properties. These controls include the logarithm of market value (*Size*), financial leverage (*Lev*), return on equity (*Roe*), growth of total assets (*Growth*), fixed asset investment (*PPE*), earnings per share (*EPS*), a dummy capturing whether the firm releases the details of R&D (*R&D_Detail*), R&D expense (*R&D Expense*), the number of patents (*Patent*), annualized stock return (*Ret*), number of analysts following the firm (*Follow*), and local economic development level (*GDP*). All variables are defined in Appendix A. Lastly, various dummies are created in Eq. (1) to control for industry, firm, and year fixed effects.[5]

5. Results and discussions

5.1. Summary statistics

Panel A of Table 2 tabulates descriptive statistics for the entire sample. The mean (median) of forecast errors (*Accuracy*) is 0.015 (0.010), comparable to Ji et al. (2019). As shown, *Accuracy* appears to follow a positively skewed distribution. Meanwhile, *Treat* averages 0.487, equivalent to the notion that approximately 48.7 percent of sample firms never reported the

[5] Some firms change their operating focus during the sample periods. We make the coding changes accordingly. The findings do not change if we do not account for industry fixed effect.

Table 2
Summary Statistics.

Panel A: Summary Statistics for All Samples

	N	Mean	Median	S.D.	Min	Max
Accuracy	2171	0.015	0.010	0.014	0.000	0.056
Treat	2171	0.487	0.000	0.500	0.000	1.000
Post	2171	0.449	0.000	0.497	0.000	1.000
Size	2171	22.616	22.502	0.893	21.051	25.139
Lev	2171	0.403	0.402	0.191	0.044	0.821
Roe	2171	0.110	0.098	0.070	−0.015	0.345
Growth	2171	0.003	0.002	0.004	−0.002	0.026
PPE	2171	0.189	0.172	0.109	0.014	0.529
EPS	2171	0.575	0.453	0.509	−0.993	2.398
Ret	2171	0.158	−0.033	0.590	−0.540	2.507
R&D Detail	2171	0.713	1.000	0.452	0.000	1.000
R&D Expense	2171	0.017	0.014	0.021	0.000	0.123
Patent	2171	3.264	3.401	1.721	0.000	7.292
Follow	2171	1.141	1.099	0.876	0.000	2.890
GDP	2171	10.787	10.853	0.447	9.706	11.513

Panel B: Summary Statistics for Treatment and Control Samples

	(1) *Treat* = 1 Treatment Firms (N = 1057)		(2) *Treat* = 0 Control Firms (N = 1,114)		(1) - (2)	
	Mean	Median	Mean	Median	t-stat	z-stat
Accuracy	0.016	0.010	0.014	0.011	1.757*	0.249
Size	22.712	22.592	22.525	22.406	4.886***	4.790***
Lev	0.462	0.463	0.347	0.331	14.697***	13.926***
Roe	0.113	0.100	0.107	0.095	2.178**	1.272
Growth	0.002	0.001	0.003	0.002	−4.531***	−3.139***
PPE	0.185	0.166	0.194	0.178	−1.878*	−2.199**
EPS	0.602	0.427	0.549	0.475	2.417**	−1.330
Ret	0.139	−0.051	0.176	−0.008	−1.486	−1.716*
R&D Detail	0.632	1.000	0.791	1.000	−8.309***	−8.181***
R&D Expense	0.010	0.000	0.025	0.020	−17.923***	−22.099***
Patent	3.319	3.466	3.211	3.332	1.462	1.523
Follow	1.126	1.099	1.155	1.099	0.766	0.882
GDP	10.733	10.765	10.839	10.899	−5.535***	−5.326***

Note: This table presents summary statistics for all samples (treatment and control samples) in Panel A (B). Panel A reports the number of observations (N), mean (Mean), median (Median), standard deviation (S.D.), minimum (Min), and maximum (Max). Panel B performs the univariate analysis between treatment and control firms. All variables are defined in Appendix A. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

R&D expense before the mandate. Firm size (*Size*), financial leverage (*Lev*), and return on equity (*Roe*) have a mean of 22.616, 0.403, and 0.110, respectively. Furthermore, around 1.141 analysts follow (*Follow*) every sample firm.

Panel B of Table 2 presents descriptive statistics for the treatment and control firms to explore their differences. From the statistical perspective, the level of forecast errors is analogous across two groups. Relative to control variables, treatment firms have a larger size, higher leverage, and greater profit despite smaller growth of assets and less detailed R&D description. On average, treatment firms operate in the area of lower economic development as reflect in the lower level of *GDP*.

5.2. Baseline DID regressions

Table 3 reports the estimated coefficients of our baseline DID regressions using different samples or dependent variables. Model 1 estimates Eq. (1) conditional on all samples, while Model 2 performs the identical regression after removing non-compliant firms (firms that do not comply with the mandatory R&D disclosure policy). For robustness, Models 3–4 repeat the same analysis but employ the dependent variable of *AccuracyEps*, which is defined as the absolute difference between actual earnings and consensus forecast, scaled by absolute actual earnings (Horton et al., 2013).

When it comes to Model 1, the coefficient on *Treat*Post* is −0.003 and differs from zero at the 5 percent significance level, demonstrating that forecast errors drop subsequent to the R&D mandate for treatment firms compared to control firms and non-disclosers. Although we estimate Model 2 based on the compliant sample, our results again suggest that mandatory R&D disclosers witness a lower post-mandate forecast error rather than voluntary counterparts, as evidenced by the accompanying negative and significant coefficient (-0.003). If *AccuracyEps* is used as the dependent variable in Eq. (1) (Models 3–4), we continue to discover a significant reduction at the 5% level in forecast errors for treatment firms in the post-mandate period.

Overall, these findings indicate that mandatory R&D reporting firms supply more relevant and useful information as a result of the mandate of R&D disclosure. Contrary to the managerial-manipulation motive, we document evidence in line with the investor-demand argument (H1a) that mandatory R&D disclosure is informative to help analysts improve their

Table 3
Baseline Regression.

	Accuracy		*AccuracyEps*	
	Full Sample	Compliant Sample	Full Sample	Compliant Sample
	(1)	(2)	(3)	(4)
Post	0.002	0.002	0.602*	0.611*
	(0.55)	(0.65)	(1.70)	(1.66)
*Treat*Post*	−0.003**	−0.003**	−0.359**	−0.378**
	(-1.99)	(-1.99)	(-2.26)	(-2.38)
Size	−0.003**	−0.002	−0.251	−0.114
	(-2.02)	(-1.41)	(-1.43)	(-0.66)
Lev	−0.003	−0.004	−1.014	−0.816
	(-0.77)	(-1.04)	(-1.60)	(-1.32)
Roe	−0.003	−0.003	−0.568	−1.535
	(-0.31)	(-0.33)	(-0.40)	(-1.05)
Growth	0.118	0.101	17.140	15.484
	(1.53)	(1.29)	(1.50)	(1.37)
PPE	0.014**	0.015***	1.634	2.388**
	(2.47)	(2.63)	(1.45)	(2.13)
EPS	0.008***	0.008***	0.246	0.258
	(4.63)	(4.46)	(1.16)	(1.21)
Ret	−0.002***	−0.002**	−0.555***	−0.507***
	(-2.60)	(-2.10)	(-5.29)	(-4.73)
R&D Detail	0.001	0.001	−0.289**	−0.196
	(0.63)	(1.35)	(-2.27)	(-1.56)
R&D Expense	0.011	0.003	−0.731	−0.994
	(0.43)	(0.11)	(-0.28)	(-0.38)
Patent	0.001**	0.001*	0.014	−0.015
	(2.21)	(1.87)	(0.24)	(-0.26)
Follow	−0.002***	−0.002***	−0.201***	−0.180**
	(-3.20)	(-3.19)	(-2.73)	(-2.38)
GDP	0.002	0.000	0.792	0.600
	(0.30)	(0.03)	(1.17)	(0.86)
Constant	0.051	0.051	−1.695	−2.960
	(0.68)	(0.65)	(-0.22)	(-0.38)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Firm	Yes	Yes	Yes	Yes
Observations	2,171	1,883	2,171	1,883
R-squared	0.142	0.134	0.090	0.089

Note: This table presents the results of baseline regressions to test the impact of mandatory R&D disclosure on analyst forecast accuracy. Compliant samples exclude the firms without reporting the R&D expense after the mandate. T-statistics are reported in parentheses underneath each estimated coefficient. Fixed effects relating to industry, year, and firm are controlled in all regressions. The number of observations and adjusted R^2 are shown at the bottom. All variables are defined in Appendix A. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

earnings forecast accuracy. Alternatively, despite the complexity and uncertainty, R&D disclosure remains a crucial source from which corporate outside stakeholders can learn more about the firm.

As revealed in Table 3, there is a positive relationship between forecast errors and earnings per share (*EPS*), consistent with Owusu-Ansah and Yeoh's (2005) argument that profitable firms have a lower accuracy of earnings forecasts. Conversely, forecast errors are negatively associated with stock return (*Ret*) and analyst following (*Follow*), again in tandem with previous literature. As negative returns somewhat pertain to a more uncertain information environment (Hope, 2003), analysts are vulnerable to committing a mistake (e.g., larger forecast errors). On the contrary, Lys and Soo (1995) articulate that competition increases with analyst following and thus prompts professionals to enhance their earnings forecast accuracy.

5.3. Mandatory R&D disclosure and information asymmetry

As discovered, analyst forecast errors significantly decline after the mandate. Nonetheless, it remains equivocal as to why such improvement in analyst forecast accuracy arises. According to the hypothesis development, information asymmetry is very likely to act as an underlying channel to connect mandatory R&D disclosure with analyst forecast accuracy. Therefore, this subsection conducts examinations in three dimensions to explore whether the R&D mandate alleviates information asymmetry so that analysts can predict more precise earnings.

5.3.1. Firm-Level information asymmetry

If mandatory R&D disclosure allows corporate outsiders to better understand a firm's operation, information asymmetry can be curbed effectively (Merkley, 2014). Depending on the quality of R&D information, financial analysts can improve their EPS forecasts. If this mechanism works, firms with serious information asymmetry are expected to react more vigorously to

the R&D mandate. Put differently, if this conjecture is valid, the positive relationship between mandatory R&D disclosure and analyst forecast accuracy is more pronounced for firms subject to higher firm-level information asymmetry.

To delineate the firm-level information environment, we identify three measures from earlier work. First, following Kothari et al. (2005), we estimate the discretionary accruals using the modified Jones model to proxy for earnings management (*EM*). Second, we refer to Loughran and McDonald (2014) to use file size to measure readability (*Readability*). Higher (lower) values of *EM* (*Readability*) correspond to more opaque information environment at the firm level. Third, we follow Morck et al. (2000) to estimate stock price synchronicity (*Synchronicity*). Consistent with Gul et al. (2010), higher synchronicity is associated with a smaller amount of earnings information being incorporated into prices, equivalent to an inferior information environment. On this basis, we leverage *EM* (*Readability, Synchronicity*) to partition the whole sample into two groups where the baseline DID regressions are replicated individually. As Panel A of Table 4 reveals, the negative coefficient on *Treat*Post* is consistently significant (insignificant) in the high (low) *EM* group. By the same token, the regarded interaction maintains negative and significant for low-*Readability* subsamples in Panel B and for high-*Synchronicity* subsamples in Panel C. Hence, evidence in Table 4 demonstrates that mandatory R&D disclosure fortifies the influence on firms announcing low quality financial statements, which corroborates with our expectation.

5.3.2. Industry-Level information asymmetry

When a firm releases useful R&D information under the mandatory setting, a positive externality may emerge owing to increased comparability in financial reports (Daske et al., 2008; Horton et al. 2013). Ultimately, intra-industry information transfers ameliorate the information environment at the industry level (Ramnath, 2002). Under this circumstance, analysts are prone to forecast future earnings in a more accurate manner. As deduced, the salutary effect of mandatory R&D disclosure should be exaggerated for firms when confronting grave industry-level information asymmetry.

Since the greater presence of firms within an industry contributes to enrich the industry information environment (Badertscher et al., 2013), we follow Chen et al. (2018) to measure the industry-level information asymmetry by the number of listed firms from the same industry (*NUMPEER*). A larger *NUMPEER* denotes a good information environment at the industry level. Similar as above, we separately perform the regression of Eq. (1) on two subsamples categorized by *NUMPEER* in Table 5. Regardless of the samples used, the estimated parameters of *Treat*Post* are persistently negative at the 1 percent significance level for the low-*NUMPEER* group. In comparison, the counterpart is insignificant, albeit negative, when investigating the high-*NUMPEER* group. Thus, these findings support our view that the accuracy-enhancement role of mandatory R&D disclosure is more conspicuous for firms operating in an industry with worsening information environment.

5.4. Mandatory R&D disclosure and analyst working conditions

Apart from information environment, analyst characteristics matter to their predictions of earnings, such as experience (Mikhail et al., 1997), access to resources (Jacob et al., 1999), and portfolio complexity (Clement, 1999). In the presence of mandatory R&D disclosure, analysts can exploit more value-relevant information despite facing tighter working constraints. If that is true to some extent, the positive impact of the R&D mandate is stronger for firms whose analysts operate under unfavorable conditions, which we dub the working-condition mechanism.

To inspect this conjecture, we measure working conditions using two indicators: the number of firms (*F_Cover*) and industries (*I_Cover*) covered by analysts. When *F_Cover* (*I_Cover*) rises, less time and attention are devoted to each firm (industry), which confines analysts to arduous working conditions (Clement and Tse, 2003). Consistent with previous practice, Table 6 reports the DID regression result for two subsamples divided by *F_Cover* (*I_Cover*). As expected, the coefficients on *Treat*Post* are negative and significant for the high *F_Cover* (*I_Cover*) subsample across two panels, while the counterparts are insignificant for the low *F_Cover* (*I_Cover*) subsample. Therefore, the association between mandatory R&D disclosure and forecast errors is stronger for firms followed by analysts who undertake more challenges. In economic terms, the informativeness of mandatory R&D disclosure may offset the adverse influence of unfavorable working conditions, which drives analysts to better fulfill their duties.

5.5. Robustness checks

5.5.1. Propensity score matching

Due to the non-randomness concern, mandatory R&D disclosers (treatment firms) may likely have different characteristics from voluntary disclosers (control firms). Such a sample selection problem possibly contaminates our baseline regression. To overcome this bias, we construct a new control sample using propensity score matching (PSM). Specifically, we run a logit regression of *Treat* on a series of variables that determine voluntary R&D disclosure according to previous literature (Li, 2010; Ellis et al., 2012). They include *HHI*, self-reported competition (*Competition*), industry-level sale rank (*SaleRank*), firm size (*Size*), return on equity (*Roe*), and local economic development level (*GDP*). Next, we harness one-to-one nearest neighbor matching to identify the paired firm in the new control group.

Forecast errors between treatment firms and new control firms are compared in Panel A of Table 7. Two findings emerge. First, treatment firms exhibit a larger forecast error in the pre-mandate or post-mandate period. Second, the reduction in forecast errors for treatment samples is much more obvious, albeit insignificant, after the implementation of mandatory

Table 4
Mandatory R&D Disclosure and Firm-Level Information Asymmetry.

Panel A: Earning Management (EM)				
	Accuracy			
	Full Sample		Compliant Sample	
	High *EM* (1)	Low *EM* (2)	High *EM* (3)	Low *EM* (4)
Post	0.013**	−0.001	0.012**	−0.001
	(2.32)	(-0.11)	(2.06)	(-0.16)
*Treat*Post*	−0.004*	−0.001	−0.004**	−0.001
	(-1.86)	(-0.45)	(-2.08)	(-0.37)
Size	−0.002	−0.004	−0.001	−0.003
	(-0.88)	(-1.58)	(-0.63)	(-1.09)
Lev	−0.011*	0.000	−0.009	−0.000
	(-1.72)	(0.02)	(-1.34)	(-0.03)
Roe	−0.014	0.035	−0.017	0.022
	(-0.92)	(1.63)	(-1.08)	(1.00)
Growth	0.138	0.345	0.153	0.196
	(1.14)	(1.42)	(1.24)	(0.79)
PPE	0.017*	0.011	0.019*	0.013
	(1.75)	(1.01)	(1.87)	(1.37)
EPS	0.008***	0.003	0.008***	0.003
	(3.05)	(0.94)	(2.96)	(0.96)
Ret	−0.002**	−0.001	−0.002*	−0.001
	(-2.08)	(-0.66)	(-1.88)	(-0.49)
R&D Detail	0.002	0.001	0.002	0.001
	(1.24)	(0.40)	(1.40)	(0.65)
R&D Expense	0.052	−0.056	0.049	−0.065
	(1.15)	(-1.44)	(1.09)	(-1.62)
Patent	0.001	0.001	0.001	0.001
	(0.93)	(1.33)	(0.88)	(1.23)
Follow	−0.002**	−0.001	−0.002**	−0.001
	(-2.32)	(-1.07)	(-2.36)	(-1.11)
GDP	−0.015	0.007	−0.014	0.006
	(-1.64)	(0.69)	(-1.45)	(0.62)
Constant	0.206*	0.017	0.182	−0.002
	(1.85)	(0.14)	(1.57)	(-0.02)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Firm	Yes	Yes	Yes	Yes
Observations	1,137	1,034	984	899
R-squared	0.168	0.119	0.162	0.115
Panel B: Readability				
	Accuracy			
	Full Sample		Compliant Sample	
	High *Readability* (1)	Low *Readability* (2)	High *Readability* (3)	Low *Readability* (4)
Post	0.002	0.000	0.001	0.001
	(0.39)	(0.02)	(0.20)	(0.17)
*Treat*Post*	−0.004**	−0.000	−0.005**	0.000
	(-2.03)	(-0.10)	(-2.27)	(0.09)
Size	−0.004**	−0.001	−0.004**	0.001
	(-2.41)	(-0.33)	(-2.07)	(0.24)
Lev	0.000	−0.002	−0.000	−0.005
	(0.00)	(-0.29)	(-0.02)	(-0.70)
Roe	−0.002	−0.013	−0.003	−0.010
	(-0.14)	(-0.66)	(-0.15)	(-0.57)
Growth	0.175	0.048	0.147	0.027
	(1.50)	(0.29)	(1.23)	(0.16)
PPE	0.012	0.011	0.010	0.019**
	(1.15)	(1.16)	(0.98)	(2.02)
EPS	0.009***	0.010***	0.008***	0.009***
	(4.13)	(3.04)	(3.91)	(2.83)
Ret	−0.002*	−0.001	−0.002	−0.001
	(-1.70)	(-0.98)	(-1.45)	(-0.56)
R&D Detail	0.002*	0.001	0.003**	0.001
	(1.77)	(0.42)	(2.13)	(0.76)

Table 4 (*continued*)

Panel A: Earning Management (EM)				
	Accuracy			
	Full Sample		Compliant Sample	
	High *EM* (1)	Low *EM* (2)	High *EM* (3)	Low *EM* (4)
R&D Expense	−0.028	0.028	−0.023	0.003
	(-0.67)	(0.73)	(-0.56)	(0.09)
Patent	0.001	0.001	0.001	0.001
	(0.87)	(1.29)	(0.93)	(1.09)
Follow	−0.002**	−0.002*	−0.002**	−0.002*
	(-2.43)	(-1.92)	(-2.31)	(-1.90)
GDP	0.008	−0.000	0.009	−0.003
	(0.92)	(-0.00)	(0.93)	(-0.27)
Constant	0.007	0.035	−0.010	0.029
	(0.07)	(0.23)	(-0.09)	(0.19)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Firm	Yes	Yes	Yes	Yes
Observations	1,168	1,003	1,017	866
R-squared	0.194	0.153	0.185	0.151
Panel C: Synchronicity				
	Accuracy			
	Full Sample		Compliant Sample	
	High *Synchronicity* (1)	Low *Synchronicity* (2)	High *Synchronicity* (3)	Low *Synchronicity* (4)
Post	0.004	−0.000	0.005	−0.001
	(0.58)	(-0.08)	(0.68)	(-0.18)
*Treat*Post*	−0.004**	0.003	−0.004**	0.002
	(-2.28)	(1.26)	(-2.22)	(0.98)
Size	−0.005**	−0.001	−0.004*	0.000
	(-2.14)	(-0.26)	(-1.75)	(0.06)
Lev	−0.001	−0.012*	0.000	−0.008
	(-0.14)	(-1.69)	(0.02)	(-1.18)
Roe	0.030**	−0.026	0.027	−0.025
	(2.01)	(-1.46)	(1.63)	(-1.39)
Growth	0.074	0.371**	0.047	0.353**
	(0.70)	(2.16)	(0.42)	(2.04)
PPE	0.018**	0.020**	0.016*	0.024**
	(2.16)	(2.14)	(1.92)	(2.56)
EPS	0.006**	0.004	0.006**	0.004
	(2.53)	(1.56)	(2.39)	(1.58)
Ret	−0.003**	−0.003**	−0.002*	−0.003*
	(-2.13)	(-2.01)	(-1.84)	(-1.78)
R&D Detail	−0.000	0.002	0.000	0.002
	(-0.33)	(1.28)	(0.02)	(1.59)
R&D Expense	0.034	−0.021	0.030	−0.020
	(0.99)	(-0.53)	(0.87)	(-0.53)
Patent	0.001	0.002***	0.001	0.002***
	(1.54)	(2.86)	(1.11)	(2.77)
Follow	−0.001**	−0.000	−0.002**	−0.001
	(-2.01)	(-0.53)	(-2.33)	(-0.52)
GDP	0.006	−0.002	0.003	−0.002
	(0.54)	(-0.23)	(0.29)	(-0.25)
Constant	0.048	0.042	0.060	0.024
	(0.34)	(0.42)	(0.41)	(0.24)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Firm	Yes	Yes	Yes	Yes
Observations	1,192	979	1,026	857
R-squared	0.197	0.136	0.182	0.137

Note: This table presents the results of baseline regressions after classifying all samples into two groups based on firm-level information asymmetry. Panel A (B, C) uses earnings management (readability, Synchronicity) to proxy for information asymmetry at the firm level. Compliant samples exclude the firms without reporting the R&D expense after the mandate. T-statistics are reported in parentheses underneath each estimated coefficient. Fixed effects relating to industry, year, and firm are controlled in all regressions. The number of observations and adjusted R^2 are shown at the bottom. All variables are defined in Appendix A. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 5
Mandatory R&D Disclosure and Industry-Level Information Asymmetry.

	Accuracy			
	Full Sample		Compliant Sample	
	High *NUMPEER*	Low *NUMPEER*	High *NUMPEER*	Low *NUMPEER*
	(1)	(2)	(3)	(4)
Post	0.002	0.004	0.002	0.005
	(0.40)	(0.73)	(0.33)	(0.89)
*Treat*Post*	−0.001	−0.006***	−0.002	−0.006***
	(-0.90)	(-3.01)	(-0.94)	(-2.79)
Size	−0.001	−0.006***	−0.001	−0.005**
	(-0.53)	(-2.62)	(-0.31)	(-2.01)
Lev	−0.008	0.011	−0.007	0.004
	(-1.58)	(1.31)	(-1.27)	(0.60)
Roe	−0.006	0.002	−0.009	0.006
	(-0.45)	(0.14)	(-0.65)	(0.42)
Growth	0.064	0.212	0.051	0.189
	(0.67)	(1.61)	(0.52)	(1.41)
PPE	0.018**	0.004	0.020**	0.005
	(2.48)	(0.43)	(2.54)	(0.76)
EPS	0.008***	0.010***	0.008***	0.009***
	(3.73)	(3.17)	(3.65)	(2.91)
Ret	−0.001	−0.003**	−0.001	−0.003**
	(-1.25)	(-2.23)	(-0.84)	(-2.22)
R&D Detail	0.000	0.001	0.001	0.002
	(0.28)	(0.94)	(0.81)	(1.29)
R&D Expense	−0.000	0.023	−0.015	0.021
	(-0.01)	(0.92)	(-0.36)	(0.81)
Patent	0.001**	0.000	0.001**	−0.000
	(2.32)	(0.02)	(2.17)	(-0.25)
Follow	−0.002***	−0.000	−0.002***	−0.001
	(-3.36)	(-0.47)	(-3.07)	(-1.10)
GDP	−0.000	0.005	−0.000	0.001
	(-0.02)	(0.50)	(-0.06)	(0.09)
Constant	0.026	0.087	0.022	0.097
	(0.27)	(0.75)	(0.22)	(0.77)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Firm	Yes	Yes	Yes	Yes
Observations	1,542	629	1,333	550
R-squared	0.145	0.168	0.137	0.171

Note: This table presents the results of baseline regressions after classifying all samples into two groups based on industry-level information asymmetry. The number of listed firms from the same industry (*NUMPEER*) is used to measure information asymmetry at the industry level. Compliant samples exclude the firms without reporting the R&D expense after the mandate. T-statistics are reported in parentheses underneath each estimated coefficient. Fixed effects relating to industry, year, and firm are controlled in all regressions. The number of observations and adjusted R^2 are shown at the bottom. All variables are defined in Appendix A. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

R&D disclosure. Panel B presents the result after re-estimating Eq. (1) based on the PSM sample. The coefficients of interest in columns (1)-(2) are negative and significant, illustrating the robustness of our main conclusion.

5.5.2. Parallel trends assumptions

As another robustness check, we investigate whether the parallel trends assumption holds for Eq. (1). To verify the validity of this assumption, we follow Dou et al. (2019) to set up a dynamic model in which *Pre(-2)*, *Pre(-1)*, and their interactions with *Treat* are added in Eq. (1). *Pre(-2)* [*Pre(-1)*] is an indicator variable taking the value of one if it is two years (one year) before enforcing the mandate.

We estimate the dynamic model and present the result in Table 8. All the interaction coefficients are insignificant for the years prior to the implementation. In contrast, the negative impact of mandatory R&D disclosure on forecast errors materializes in the year of introduction itself. From this angle, the parallel trends assumption is satisfied in our setting, which ensures the reliability of our prior inference.

5.5.3. Additional tests

We perform several robustness checks pertinent to variable measurement in Table 9. Panel A repeats the regression of Eq. (1) with corporate site visits of analysts (*Visit*) as an alternative measure of analyst forecast accuracy. If useful information is acquired directly from mandatory R&D disclosure, analysts would reduce the number of their site visits to firms. We obtain analogous empirical evidence to that in Table 3. Panel B investigates whether the negative coefficient persists when recomputing forecast errors using alternative measurement windows. Specifically, we employ 60/90 days after the last earn-

Table 6
Mandatory R&D Disclosure and Analyst Working Conditions.

	Panel A: Number of Firms Covered (*F_Cover*				Panel B: Number of Industries Covered (*I_Cover*)			
	Accuracy				*Accuracy*			
	Full Sample		Compliant Sample		Full Sample		Compliant Sample	
	High *F_Cover*	Low *F_Cover*	High *F_Cover*	Low *F_Cover*	High *I_Cover*	Low *I_Cover*	High *I_Cover*	Low *I_Cover*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post	0.004	0.003	0.004	0.003	0.011**	−0.005	0.011*	−0.006
	(0.76)	(0.51)	(0.70)	(0.46)	(2.09)	(-0.92)	(1.89)	(-0.96)
*Treat*Post*	−0.004*	−0.001	−0.004**	−0.001	−0.004*	0.001	−0.004**	0.001
	(-1.82)	(-0.26)	(-1.98)	(-0.26)	(-1.95)	(0.40)	(-1.99)	(0.37)
Size	−0.004**	−0.000	−0.004*	−0.000	−0.007***	0.002	−0.006***	0.002
	(-2.09)	(-0.20)	(-1.82)	(-0.02)	(-3.50)	(0.70)	(-3.25)	(0.69)
Lev	0.002	−0.001	−0.003	0.001	−0.005	0.003	−0.003	−0.001
	(0.28)	(-0.09)	(-0.48)	(0.12)	(-0.72)	(0.38)	(-0.39)	(-0.12)
Roe	−0.000	−0.003	0.003	−0.009	0.025	−0.036**	0.025	−0.038**
	(-0.03)	(-0.20)	(0.16)	(-0.48)	(1.58)	(-2.03)	(1.47)	(-2.21)
Growth	0.080	0.185	0.049	0.194	0.255**	−0.051	0.249*	−0.038
	(0.62)	(1.05)	(0.38)	(1.10)	(1.99)	(-0.40)	(1.92)	(-0.28)
PPE	−0.003	0.025***	−0.003	0.025***	−0.000	0.030***	0.000	0.029***
	(-0.31)	(2.66)	(-0.35)	(2.64)	(-0.03)	(2.84)	(0.05)	(2.68)
EPS	0.009***	0.005*	0.008***	0.005**	0.006**	0.010***	0.006*	0.010***
	(3.04)	(1.94)	(2.64)	(2.04)	(2.03)	(4.30)	(1.79)	(4.30)
Ret	−0.004**	−0.000	−0.004**	−0.000	−0.003***	−0.001	−0.003**	−0.001
	(-2.46)	(-0.32)	(-2.29)	(-0.20)	(-2.60)	(-0.94)	(-2.47)	(-0.93)
R&D Detail	−0.001	0.002	0.000	0.002*	0.000	0.001	0.001	0.002
	(-0.36)	(1.30)	(0.06)	(1.67)	(0.00)	(0.96)	(0.43)	(1.34)
R&D Expense	0.026	0.011	0.001	0.014	0.017	0.009	0.001	0.001
	(0.56)	(0.28)	(0.02)	(0.35)	(0.47)	(0.26)	(0.04)	(0.04)
Patent	0.001	0.001*	0.000	0.001	0.001	0.000	0.001	0.000
	(0.72)	(1.69)	(0.55)	(1.54)	(0.87)	(0.50)	(1.22)	(0.33)
Follow	−0.000	−0.002***	−0.000	−0.002***	−0.001	−0.002**	−0.001	−0.002**
	(-0.26)	(-2.91)	(-0.48)	(-2.83)	(-0.89)	(-2.17)	(-0.72)	(-2.23)
GDP	−0.000	−0.005	−0.000	−0.006	−0.012	0.013	−0.013	0.015
	(-0.00)	(-0.49)	(-0.00)	(-0.55)	(-1.37)	(1.23)	(-1.36)	(1.35)
Constant	0.099	0.066	0.087	0.063	0.284***	−0.171	0.279**	−0.185
	(0.97)	(0.51)	(0.81)	(0.49)	(2.66)	(-1.37)	(2.45)	(-1.46)
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,095	1,076	898	985	1,130	1,041	954	929
R-squared	0.156	0.134	0.160	0.128	0.157	0.178	0.157	0.177

Note: This table presents the results of baseline regressions after classifying all samples into two groups based on analyst working conditions. Panel A (B) uses the number of firms (industries) covered to measure analyst working conditions. Compliant samples exclude the firms without reporting the R&D expense after the mandate. T-statistics are reported in parentheses underneath each estimated coefficient. Fixed effects relating to industry, year, and firm are controlled in all regressions. The number of observations and adjusted R^2 are shown at the bottom. All variables are defined in Appendix A. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

ings announcement to estimate analyst forecast accuracy (*Accuracy60*/*Accuracy90*). The regarded coefficient suggests that our main results are free from the arbitrary selection of time horizons. In Panel C, we re-estimate the baseline model using the standard deviation of actual earnings and consensus forecast issued by analysts 30 days after the last annual earnings announcement, scaled by the beginning-of-the-year stock price (*Dispersion*) as an alternative metric for analyst forecast accuracy. The coefficients of *Treat*Post* remain negative and significant at the 10% level.

We conduct two additional robustness checks. First, we change the criteria to define control firms. Specifically, we require control firms meeting the condition of disclosing their R&D expenses every year before the mandate. We present the findings in Panel A of Table 10. The coefficients of *Treat*Post* continue to be negative and significant at the conventional level in Panel A. Second, we delete 2012 to avoid the incomplete implementation of the mandatory disclosure policy. The findings in Panel B shows that the coefficients of *Treat*Post* remain qualitatively similar to those in Table 3.

6. Summary and conclusion

As a reform of information disclosure in China, listed firms with R&D investments have been mandated to publish R&D information since 2012. Leveraging the unique regulatory setting, along with the fact that some firms have voluntarily dis-

Table 7
Robustness Check I: Propensity Score Matching Procedures.

Panel A: Univariate Analyses using PSM Sample

Full Sample

	Treatment Firms	Control Firms (After PSM)	Diff
Pre-mandate period	0.017	0.015	0.002**
Post-mandate period	0.015	0.014	0.001
Diff-in-Diff			−0.001

Compliant Sample

	Treatment Firms	Control Firms (After PSM)	Diff
Pre-mandate period	0.016	0.014	0.002*
Post-mandate period	0.015	0.014	0.001
Diff-in-Diff			−0.001

Panel B: Baseline Regressions using PSM Sample

	Accuracy	
	Full Sample (1)	Compliant Sample (2)
Post	−0.002	−0.002
	(-1.64)	(-1.22)
*Treat*Post*	−0.003**	−0.003**
	(-2.00)	(-2.14)
Size	−0.005***	−0.004***
	(-4.64)	(-4.34)
Lev	−0.005	−0.004
	(-0.90)	(-0.82)
Roe	0.000	0.001
	(0.03)	(0.12)
Growth	0.197**	0.059
	(2.33)	(0.58)
PPE	0.012*	0.016**
	(1.69)	(2.19)
EPS	0.009***	0.009***
	(4.75)	(4.54)
Ret	0.000	0.001
	(0.24)	(1.29)
R&D Detail	0.001	0.001
	(0.56)	(1.20)
R&D Expense	0.018	0.001
	(0.77)	(0.04)
Patent	0.001***	0.001***
	(2.97)	(2.83)
Follow	−0.002***	−0.002***
	(-2.83)	(-3.55)
GDP	0.013***	0.010***
	(3.76)	(2.59)
Constant	−0.013	0.009
	(-0.34)	(0.22)
Industry	Yes	Yes
Year	Yes	Yes
Firm	Yes	Yes
Observations	1,613	1,307
R-squared	0.099	0.107

Note: This table presents the impact of mandatory R&D disclosure on analyst forecast accuracy using the PSM sample. Panel A performs the univariate analysis for *Accuracy* between treatment firms and PSM control firms. Panel B presents the baseline regression using the PSM sample. Compliant samples exclude the firms without reporting the R&D expense after the mandate. T-statistics are reported in parentheses underneath each estimated coefficient. Fixed effects relating to industry, year, and firm are controlled in all regressions. The number of observations and adjusted R^2 are shown at the bottom. All variables are defined in Appendix A. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

closed R&D information before such reform, we examine whether mandatory R&D disclosure matters to analyst forecast accuracy. Using a DID research design, we discover that forecast errors reduce more substantially for mandatory R&D reporting firms than for voluntary R&D reporting firms after the implementation year. In other words, mandatory R&D disclosure facilitates analysts to enhance analyst forecast accuracy by providing value-relevant information. Furthermore, we find that the impact of R&D mandate is found to be strengthened for firms with higher information asymmetry or with analysts

Table 8
Robustness Check II: Parallel Trend Assumptions.

	Accuracy	
	Full Sample	Compliant Sample
	(1)	(2)
Pre(-2)	0.005***	0.005***
	(3.60)	(3.38)
Pre(-1)	0.012***	0.012***
	(6.25)	(5.93)
Post	0.008***	0.009***
	(3.37)	(3.55)
Treat Pre(-2)*	−0.003	−0.003
	(-1.64)	(-1.33)
Treat Pre(-1)*	−0.001	−0.001
	(-0.85)	(-0.77)
*Treat*Post*	−0.004**	−0.004**
	(-2.15)	(-1.97)
Size	−0.003**	−0.002*
	(-2.54)	(-1.88)
Lev	−0.004	−0.005
	(-0.90)	(-1.13)
Roe	−0.002	−0.003
	(-0.23)	(-0.28)
Growth	0.125	0.105
	(1.64)	(1.36)
PPE	0.015**	0.015**
	(2.49)	(2.58)
EPS	0.008***	0.008***
	(4.77)	(4.60)
Ret	0.000	0.000
	(0.37)	(0.84)
R&D Detail	0.001	0.001
	(0.70)	(1.39)
R&D Expense	0.001	−0.006
	(0.05)	(-0.26)
Patent	0.001**	0.001**
	(2.50)	(2.16)
Follow	−0.001***	−0.002***
	(-2.92)	(-2.92)
GDP	−0.004	−0.007
	(-0.90)	(-1.46)
Constant	0.108**	0.123**
	(2.32)	(2.58)
Industry	Yes	Yes
Year	Yes	Yes
Firm	Yes	Yes
Observations	2,171	1,883
R-squared	0.123	0.113

Note: This table examines the validity of the parallel trend assumption. Compliant samples exclude the firms without reporting the R&D expense after the mandate. T-statistics are reported in parentheses underneath each estimated coefficient. Fixed effects relating to industry, year, and firm are controlled in all regressions. All variables are defined in Appendix A. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

working under unfavorable conditions. These findings are consistent with the argument that useful R&D disclosure helps improve the information environment and mitigate adverse working conditions, consequently leading to a better earnings prediction from analysts. Finally, we demonstrate that this conclusion holds under various robustness checks.

There are two caveats in interpreting our findings. First, akin to other studies relying on an exogenous shock, it is difficult to ascribe the observed association to causality because correlated, omitted variables may prevail. We attempt to identify the genuine effect of mandatory R&D disclosure by analyzing underlying mechanisms and performing robustness checks. Second, our inference is reliable when considering forecast errors as the measure of analyst forecast accuracy. It may not be the case if extended to other proxies such as forecast dispersion and forecast revision.

Table 9
Robustness Check III: Additional Tests.

	Panel A: Analyst Visit		Panel B: Alternative Measurement Windows				Panel C: Analyst Dispersion	
	Visit		*Accuracy60*		*Accuracy90*		*Dispersion*	
	Full Sample (1)	Compliant Sample (3)	Full Sample (2)	Compliant Sample (3)	Full Sample (4)	Compliant Sample (5)	Full Sample (6)	Compliant Sample (7)
Post	0.924***	1.034***	−0.001	−0.000	−0.001	−0.000	−0.001	−0.002
	(3.78)	(3.93)	(-0.27)	(-0.05)	(-0.28)	(-0.08)	(-1.21)	(-1.60)
*Treat*Post*	−0.715***	−0.689***	−0.005***	−0.005***	−0.005***	−0.005***	−0.001*	−0.001*
	(-6.75)	(-6.52)	(-2.81)	(-2.72)	(-2.82)	(-2.73)	(-1.78)	(-1.73)
Size	0.123	0.140	−0.000	0.001	−0.000	0.001	−0.000	−0.000
	(1.18)	(1.28)	(-0.03)	(0.56)	(-0.01)	(0.58)	(-0.87)	(-0.85)
Lev	0.277	0.337	−0.008	−0.008	−0.006	−0.007	0.000	0.000
	(0.96)	(1.08)	(-1.18)	(-1.22)	(-1.00)	(-1.07)	(0.25)	(0.25)
Roe	2.196***	2.233***	−0.039**	−0.038**	−0.035**	−0.033**	−0.013***	−0.014***
	(2.81)	(2.73)	(-2.57)	(-2.41)	(-2.26)	(-2.08)	(-3.35)	(-3.73)
Growth	−14.971**	−15.906**	0.259*	0.232	0.248*	0.217	0.086***	0.082**
	(-2.10)	(-2.19)	(1.80)	(1.58)	(1.82)	(1.56)	(2.59)	(2.45)
PPE	0.424	0.359	0.021**	0.025***	0.021**	0.025***	0.003	0.004
	(1.03)	(0.82)	(2.45)	(2.72)	(2.48)	(2.76)	(1.34)	(1.62)
EPS	−0.288**	−0.271**	0.021***	0.021***	0.020***	0.020***	0.002***	0.002***
	(-2.34)	(-2.19)	(7.66)	(7.40)	(7.34)	(7.08)	(3.86)	(3.97)
Ret	0.071	0.065	−0.008***	−0.008***	−0.008***	−0.008***	−0.002***	−0.001***
	(1.34)	(1.18)	(-8.04)	(-7.41)	(-7.88)	(-7.26)	(-6.46)	(-6.25)
R&D Detail	0.074	0.068	0.001	0.002	0.001	0.002*	−0.000	−0.000
	(1.19)	(1.04)	(0.83)	(1.61)	(0.90)	(1.72)	(-0.33)	(-0.03)
R&D Expense	−1.368	−1.431	0.066*	0.048	0.062	0.044	0.016**	0.013*
	(-0.83)	(-0.84)	(1.68)	(1.25)	(1.63)	(1.19)	(2.31)	(1.74)
Patent	0.043	0.041	0.001	0.001	0.001	0.001	−0.000	−0.000
	(1.31)	(1.18)	(1.56)	(1.27)	(1.61)	(1.24)	(-0.99)	(-0.70)
Follow	0.079**	0.072*	−0.002**	−0.003***	−0.003**	−0.003***	0.001***	0.001***
	(2.08)	(1.80)	(-2.33)	(-2.63)	(-2.49)	(-2.79)	(3.44)	(3.22)
GDP	−0.124	−0.354	0.008	0.004	0.008	0.005	0.001	0.002
	(-0.28)	(-0.74)	(0.88)	(0.43)	(0.93)	(0.52)	(0.46)	(0.82)
Constant	−1.161	0.881	−0.074	−0.062	−0.077	−0.070	−0.000	−0.008
	(-0.24)	(0.17)	(-0.69)	(-0.56)	(-0.74)	(-0.64)	(-0.02)	(-0.34)
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,171	1,883	2,171	1,883	2,171	1,883	1,623	1,472
R-squared	0.226	0.229	0.237	0.233	0.232	0.229	0.213	0.209

Note: This table conducts additional robustness checks. Panel A examines the impact of mandatory R&D disclosure on analyst corporate site visits. Panel B repeats the regression after constructing forecast errors using alternative measurement windows. Panel C re-estimates the baseline model using analyst forecast dispersion as the proxy for analyst forecast quality. Compliant samples exclude the firms without reporting the R&D expense after the mandate. T-statistics are reported in parentheses underneath each estimated coefficient. Fixed effects relating to industry, year, and firm are controlled in all regressions. The number of observations and adjusted R^2 are shown at the bottom. All variables are defined in Appendix A. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 10
Robustness Check IV: Additional Tests Using Alternative Samples.

	Panel A: Redefining Control Firms		Panel B: Deleting Year 2012	
	Accuracy		*Accuracy*	
	Full Sample	Full Sample	Compliant Sample	Compliant Sample
	(6)	(6)	(7)	(7)
Post	−0.000	0.000	0.001	0.002
	(-0.07)	(0.06)	(0.29)	(0.40)
*Treat*Post*	−0.003**	−0.003**	−0.003**	−0.004***
	(-2.02)	(-2.06)	(-2.55)	(-2.61)
Size	−0.002*	−0.002	−0.003**	−0.002*
	(-1.70)	(-1.24)	(-2.37)	(-1.69)
Lev	−0.001	−0.002	−0.000	−0.001
	(-0.23)	(-0.53)	(-0.03)	(-0.19)
Roe	−0.011	−0.009	0.002	0.003
	(-1.03)	(-0.81)	(0.14)	(0.23)
Growth	0.137*	0.127	0.167*	0.153*
	(1.72)	(1.57)	(1.90)	(1.70)
PPE	0.012*	0.013**	0.010	0.011
	(1.94)	(2.07)	(1.50)	(1.60)
EPS	0.009***	0.009***	0.007***	0.007***
	(4.66)	(4.43)	(3.91)	(3.73)
Ret	−0.002*	−0.001	−0.002**	−0.001
	(-1.95)	(-1.42)	(-2.22)	(-1.64)
R&D Detail	0.001	0.002*	0.001	0.001
	(1.40)	(1.77)	(0.56)	(1.34)
R&D Expense	0.020	0.016	0.005	−0.002
	(0.63)	(0.50)	(0.18)	(-0.09)
Patent	0.001**	0.001**	0.001**	0.001
	(2.35)	(2.11)	(2.06)	(1.63)
Follow	−0.002***	−0.002***	−0.002***	−0.002***
	(-2.85)	(-2.84)	(-3.02)	(-3.07)
GDP	0.006	0.005	0.005	0.003
	(0.92)	(0.70)	(0.85)	(0.53)
Constant	0.002	0.001	0.028	0.027
	(0.02)	(0.01)	(0.38)	(0.35)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Firm	Yes	Yes	Yes	Yes
Observations	1,875	1,614	1,855	1,571
R-squared	0.151	0.149	0.162	0.155

Note: This table conducts additional robustness checks. Panel A re-estimates the baseline model when redefining control firms by requiring them to disclose R&D expenses every year before the mandate. Panel B repeats the regression after deleting observations in year 2012. Compliant samples exclude the firms without reporting the R&D expense after the mandate. T-statistics are reported in parentheses underneath each estimated coefficient. Fixed effects relating to industry, year, and firm are controlled in all regressions. The number of observations and adjusted R^2 are shown at the bottom. All variables are

CRediT authorship contribution statement

Baohua Liu: Conceptualization, Methodology, Supervision, Project administration. **Dan Huang:** Conceptualization, Methodology, Software, Formal analysis, Data curation, Writing – review & editing, Supervision, Project administration, Funding acquisition. **Tao Chen:** Writing – original draft, Visualization. **Kam C. Chan:** Conceptualization, Supervision, Project administration.

Data availability

Data will be made available on request.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Examples on the implementation of mandatory R&D disclosure

We take four examples to illustrate how the mandatory R&D disclosure is implemented by different firms.

Example 1: Guangdong Xinhui Meida Nylon Co., LTD. (Stock Code: 000782) for fiscal year 2012

Total R&D Expenditure	Proportion of Total R&D Expenditure to Net Assets	Proportion of Total R&D Expenditure to Operating Income
100,417,717.40	9.20%	2.63%

Example 2: Zhejiang Vie Science& Technology Co., Ltd (Stock Code: 002590) for fiscal year 2012

Item	2012	2011	Year-on-year change	2010
Total R&D Expenditure	35,227,552.58	33,654,739.83	4.67%	29,370,164.11
Operating Income	1,020,684,449.94	1,001,742,663.66	1.89%	867,622,633.54
Proportion of Total R&D Expenditure to Operating Income	3.45%	3.36%	0.09%	3.39%
Net Assets	662,237,600.98	660,706,574.26	0.23%	287,168,185.5
Proportion of Total R&D Expenditure to Net Assets	5.32%	5.09%	0.23%	10.23%

Example 3: Tonghua Dongbao Pharmaceutical Co., Ltd (Stock Code: 600867) for fiscal year 2012

(1) Description of R&D Expenditure

Expensing R&D Expenditure	47,160,136.17
Total R&D Expenditure	47,160,136.17
Proportion of Total R&D Expenditure to Net Assets	2.37%
Proportion of Total R&D Expenditure to Operating Income	4.76%

(2) Description of R&D activities

During the reporting period, our total direct investment in R&D activities was 47.16 million yuan, accounting for 2.37% of net assets and 4.76% of operating income. We have continuously increased R&D investment to develop the R&D platform of biopharmaceuticals and traditional Chinese medicine. By doing so, we tend to gradually explore a diversified scientific research management model adapted to our own characteristics to ensure the realization of our strategic objectives. We have researched and developed 4 insulin analogues with a total of 20 specifications, and have completed all process studies, of which 6 specifications are under review. Meanwhile, we have carried out the development of oral drugs in the field of diabetes, and the secondary development of Zhennaoning capsules (Zhennaoning tablets).

Example 4: Livzou Pharmaceutical Group Inc. (Stock Code: 000513) for fiscal year 2012

During the reporting period, our direct and indirect investment in R&D activities was 20,137.17 million yuan, accounting for 6.33% of net assets and 5.11% of operating income.

During the reporting period, our key R&D projects were good going. For the McAb project, we have completed the pre-clinical experiment of the AT132 project product and submitted the clinical experiment application to SFDA. Meanwhile, we have completed the research and development and pilot production of lz002 project and started the purification process research of lz003 project. For the vaccine project, we have determined the production process and quality control standards of Japanese encephalitis vaccine, formulated the registration standards, improved, and standardized the process operation. The production registration and new drug certificate application materials have been submitted to the drug regulatory authorities and accepted. In addition, we have obtained the re-registration approval of the raw materials and preparations of eprazole in September and November respectively, completed the phase IV clinical study on the raw materials and preparations of epprazole in August, completed the clinical study on the Brennserin materials and tablets, and completed preclinical pharmaceutical and pharmacological toxicological studies on the acarbose tablets and eprazole sodium for injection.

The above R&D projects has laid the foundation for our future product transformation and the continuous growth of performance.

Appendix B. Variable definitions

Variable	Definition
Accuracy	Analyst forecast accuracy, which is defined as the absolute difference between actual earnings and consensus forecast, scaled by the beginning-of-the-year stock price. Consensus forecast is the median of earnings predictions issued by analysts for the first time within 30 days after the last earnings announcement
Treat	An indicator variable taking the value of one (zero) if a firm never (ever) reports the R&D expense in the pre-mandate period
Post	An indicator variable taking the value of one in the post-mandate period (years 2012, 2013, and 2014) and zero otherwise
Size	Natural logarithm of market capitalization
Lev	Leverage, which is computed by total liabilities over total assets at the fiscal year-end
Roe	Return on equity, which is computed by net income over year-end total equity
Growth	Growth rate of total assets
PPE	Plant property equipment ratio, which is computed by total fixed assets over total assets at the fiscal year-end
EPS	Earnings per share
Ret	Market performance, which is proxied by the annual stock return
R&D Detail	A dummy variable equals one if the firm discloses the details of R&D projects and zero otherwise
R&D Expense	R&D Expense, which is computed by the R&D expenditure over total assets at the fiscal year-end
Patent	Natural logarithm of the number of patents (plus one)
Follow	Analyst following, which is measured by the natural logarithm of the number of analysts following the firm
GDP	Economic development level, which is measured by local gross domestic product
AccuracyEps	Alternative measure of analyst forecast accuracy, which is defined as the absolute difference between actual earnings and consensus forecast issued by analysts 30 days after the last annual earnings announcement, scaled by the actual earnings
Dispersion	Alternative measure of analyst forecast accuracy, which is defined as the standard deviation of actual earnings and consensus forecast issued by analysts 30 days after the last annual earnings announcement, scaled by the beginning-of-the-year stock price
EM	Accrual-based measure of earnings management, which is estimated by the cross-sectional modified Jones model (Kothari et al., 2005)
Readability	Readability measure of financial statements, which is measured as file size according to Loughran and McDonald (2014)
NUMPEER	The number of listed firms from the same industry (Chen et al., 2018)
Synchronicity	Stock price synchronicity, which is estimated following Morck et al. (2000)
F_Cover	Analyst portfolio complexity measured by average number of firms covered by analysts
I_Cover	Analyst portfolio complexity measured by average number of industries covered by analysts
Competition	Measure of self-reported competition, which is proxied by the number of words relating to competition in annual financial statements
SaleRank	Industry-level sale rank
Visit	Average number of corporate site visits by analysts
Accuracy60	Analyst forecast accuracy, which is defined as the absolute difference between actual earnings and consensus forecast, scaled by the beginning-of-the-year stock price. Consensus forecast is the median of earnings predictions issued by analysts for the first time within 60 days after the last earnings announcement
Accuracy90	Analyst forecast accuracy, which is defined as the absolute difference between actual earnings and consensus forecast, scaled by the beginning-of-the-year stock price. Consensus forecast is the median of earnings predictions issued by analysts for the first time within 90 days after the last earnings announcement

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