The Amount and Quality of R&D Capitalization under International Financial Reporting Standards (IFRS)

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* Corresponding author. We appreciate helpful comments and suggestions from Kris Allee, John Jiang, and workshop participants at the 2022 Renmin University of China PhD Student Conference. This paper also benefited from discussions with Rich Jones, Paul Munter, and other participants at the 2023 Financial Reporting Issues Conference (FRIC) held at the Financial Accounting Standards Board offices in Norwalk, CT.

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Abstract: The Financial Accounting Standards Board (FASB) is currently investigating how to improve the accounting for R&D costs. We examine the amount and quality of capitalized R&D costs when firms are allowed to do so under IFRS, and offer four main findings. First, less than one-third of firm-years with R&D costs capitalize any amount of R&D, and, among those that do, only one-fifth of total R&D costs are capitalized. These findings suggest that, when given discretion, firms do not appear to capitalize significant amounts of R&D. Second, we predict and find that R&D labor costs are a proxy for R&D quality, as evidenced by a lower likelihood of cutting R&D spending and lower R&D employee turnover, and a greater number of current and future patents. Third, we find a positive association between this proxy for R&D quality and the amount of R&D costs that firms capitalize. This suggests that, when given discretion, firms appear to capitalize R&D of high quality. Finally, we find that capitalized R&D costs are positively associated with investors pricing, but *only* when R&D is high quality. In additional analysis, we examine real effects from a recent IFRS-country R&D disclosure mandate, finding that it increased both the level and quality of R&D expenditures. Overall, our findings suggest that when R&D can be capitalized and disclosure quality is high, firms appear to capitalize legitimate R&D costs, and that, at a minimum, the FASB can improve R&D accounting by requiring firms to disclose R&D information, including labor costs.

Keywords: R&D accounting; Disclosure regulation; R&D labor costs; Innovation

1. Introduction

The Financial Accounting Standards Board (FASB) is currently investigating how to improve the accounting for R&D costs (FASB 2023). Most constituents agree that at least a portion of R&D costs meet the conceptual framework's definition of an asset (e.g., a present right to an economic benefit), but express concern that the difficulty in measuring the amount to capitalize precludes firms from reliably representing that portion of R&D costs on the balance sheet. Furthermore, some express concern that firms would exploit the discretion to capitalize R&D costs, resulting in overcapitalization and subsequent impairments of these amounts. International Financial Reporting Standards (IFRS) allow all firms to capitalize R&D costs under specific conditions. This study seeks to answer two primary research questions: (1) How prevalent is R&D capitalization under IFRS?, and (2) Are the R&D costs that firms capitalize of high quality?

To explore these questions, we use unique R&D disclosures recently required in China, where accounting standards have substantially converged with IFRS. These disclosures are not typically available under US GAAP or in primary IFRS-adopting countries. Specifically, Chinese reporting guidelines require firms to disclose R&D capitalization (as well as its proportion to total R&D expenditure) and the separate disclosure of R&D expenses in income statements.[1] This disclosure allows for a more precise depiction of R&D, as firms categorize R&D expenses into labor, materials, overhead, and other relevant categories.[2] In additional analysis, we explore the extent to which this enhanced disclosure mandate had real effects on the level and quality of firms' R&D expenditures.

[1] This requirement mitigates the "missing R&D" issue identified by Koh and Reeb (2015) in the U.S. context, where 10% of firms not reporting R&D expenses are actively conducting research.

[2] The same level of disclosure does not exist in other primary IFRS adoption countries, such as the UK. We searched the 2022 annual reports of the top 10 market cap firms in the UK and found that only two firms explicitly disclose capitalized amounts of R&D. Under US GAAP, a subset of firms (i.e., software firms) are allowed to capitalize certain amounts of R&D. However, the disclosure there also appears incomplete. Specifically, we similarly searched the 2022 annual reports of the top 10 software firms in the U.S. and found that only two firms explicitly disclose the capitalized amounts of R&D.

Using a sample of non-financial Chinese firms with identifiable R&D information from 2017 to 2021, we examine the prevalence and extent of R&D capitalization. Out of 11,692 firm-year observations with non-zero R&D costs, only 29 percent capitalize R&D of any amount, and the average capitalization rate is as low as 7 percent. That is, 71 percent of firm-years do not capitalize *any* amount of R&D costs. Among the firm-year observations where capitalization occurs, the average capitalization rate is 22 percent, or one fifth of total R&D costs.[3] These findings suggest that, when firms are given discretion to capitalize R&D under IFRS, they do not appear to capitalize significant amounts of R&D costs.

Next, we explore the quality of capitalized R&D costs. We use managers' economic decisions on R&D labor investment as a proxy for the quality of a firm's R&D program. Specifically, intensive investment in R&D labor indicates a strong managerial commitment to innovation and breakthroughs. This commitment suggests that managers hold a strong belief in the long-term benefits of their research activities. Furthermore, substantial R&D labor investment enhances the likelihood of successful research outcomes, as the expertise and effort of R&D personnel are the primary drivers of research success (Cohen and Levinthal, 1990; Griliches, 1979; Romer, 1990).

China's R&D disclosure mandate offers a unique opportunity to measure firms' R&D labor investment. As previously discussed, firms typically categorize R&D expenses into labor, materials, overhead, and other relevant categories, shedding light on the wage expenses incurred for R&D workers. Using this information, we estimate the compensation paid to R&D personnel and gauge R&D labor costs at the firm level.[4]

We first validate R&D labor costs as a proxy for R&D quality by establishing that R&D

[3] As explained more fully in Section 2, we focus on the percent of *total* R&D costs that are capitalized, rather than the proportion of development costs, because we view the distinction between research costs and development costs to be subject to managerial discretion.
[4] We use the terms "R&D labor investment" and "R&D labor cost" interchangeably. Both terms capture firms' investment in R&D human capital.

labor cost reflects managers' commitment to R&D investment. We find that R&D labor cost is negatively associated with the likelihood that managers cut R&D expense. This finding suggests that managers allocating more resources to R&D labor tend to exhibit less myopic behavior, showing a greater willingness to invest for the long term. We also find a positive association between R&D labor cost and (1) the number of patent applications the firm makes, (2) the number of future patents granted to the firm, and (3) the retention of a firm's R&D workforce. These associations suggest that investing heavily in R&D human capital provides managers with not only a stable workforce but also successful innovation outcomes. Overall, these results suggest that R&D labor cost serves as a suitable proxy for R&D quality, such that when managers allocate significant resources toward R&D labor, it appears to reflect their commitment to maintaining and enhancing the quality of their R&D programs.

To explore the quality of R&D capitalization, we regress it on R&D labor cost, alongside other known determinants of R&D capitalization (Aboody and Lev 1998; Oswald 2008; Oswald, Simpson, and Zarowin 2022). Our regression analysis yields two primary observations. First, firms with greater R&D labor costs are more likely to capitalize R&D. Secondly, these firms tend to have a higher R&D capitalization rate. These findings remain across alternative fixed effect estimation and clustering methods, alternative regression models, and alternative calculations of key variables. The results suggest that greater investment in R&D labor signifies managerial intent and capacity to achieve success in research and development, which positions R&D costs as more qualified for capitalization. In this sense, R&D capitalization is of higher quality because it is underpinned by economic substance.

Next, we explore whether capitalized R&D reflects the information that investors incorporate into price. We find a positive association between R&D capitalization amount and contemporaneous stock returns. Because stock returns reflect the market's collective view of a firm's future prospects, this positive relationship suggests that investors view the capitalized

R&D as an asset likely to produce future economic benefits. Further, we explore the value relevance of R&D capitalization conditional on firms' investment in R&D labor. We find that the value relevance of R&D capitalization only holds for firms with higher R&D labor costs (i.e., higher quality R&D). This finding suggests that when R&D capitalization is generally allowed and disclosure quality is high, investors appear to recognize and *only* place a premium on firms that capitalize high quality R&D.

In additional analysis, we examine whether the regulation of R&D disclosure in China has any effect on the disclosure, amount, or quality of firms' R&D. Consistent with the regulation increasing R&D disclosure, we find that firms' filings have more R&D-related words after the disclosure mandate. More importantly, we find that R&D investment levels and quality increase after the disclosure mandate, suggesting that requiring firms to disclose this detailed information about R&D activity has real effects. Perhaps most interestingly, firms that previously had low-quality R&D increase their R&D quality to a greater extent afterwards. Taken together, our evidence suggests that when China mandated R&D disclosure, there was a noticeable change in both the level and quality of firms' R&D.

Our study contributes to the literature in several ways. First, we offer a comprehensive view of firms' R&D capitalization practices in a unique setting where every firm is mandated to disclose R&D capitalization. Unlike prior research, which mainly focuses on firms that voluntarily disclose R&D capitalization, our setting alleviates the potential bias of selective or discretionary R&D disclosure. For instance, Aboody and Lev (1998) study a small sample of 163 U.S. software firms with identifiable capitalization information and find that 70% capitalize R&D costs. Similarly, Oswald (2008) examine 3,229 UK firms before the IFRS mandate. They determine R&D capitalization from firms' voluntary disclosure of intangible development assets or their amortization, and find that only 14.9% report capitalized R&D. In contrast, our research indicates that in a setting with mandatory disclosure where all firms have the discretion to capitalize R&D costs, 29% of firm-years with R&D costs capitalize any amount of those costs. Interestingly, despite having the option, most firms either do not capitalize or capitalize only a small portion. Furthermore, because innovation levels in China are similar to those in the US, as evidenced by a similar R&D expenditure to GDP ratio and patent applications per capita (WIPO 2023), our study offers potential insights to US standard setters who might be concerned about overcapitalization if the capitalization rule currently allowed for some U.S. software firms is applied universally to all U.S. firms.[5]

Second, we contribute to the literature on the economic determinants of R&D capitalization. Prior research investigates the determinants of R&D capitalization in specific contexts: the U.S. software industry and the U.K.'s pre-IFRS adoption period, respectively. However, their findings are somewhat mixed. Aboody and Lev (1998) find that R&D intensity positively relates to R&D capitalization, while Oswald (2008) and Oswald, Simpson, and Zarowin (2022) find the opposite. We explore R&D capitalization across *all* the listed firms in a country where there is a mandate for R&D capitalization disclosure under IFRS. We find that R&D labor input is positively associated with R&D capitalization, and is the largest contributor to R&D capitalization among all important determinants identified by prior research. Its standardized coefficient estimate suggests that a one-standard-deviation increase in R&D labor cost is associated with a 12% standard-deviation increase in R&D capitalization amount. We also find that R&D labor input, R&D intensity, and firm size are the primary drivers for R&D capitalization. These findings suggest that the amount of R&D capitalization is determined primarily by firms' capacity to capitalize, rather than an inclination towards over-capitalization to manage earnings or other myopic reasons. Taken together, our analyses suggest that firms capitalize R&D for legitimate reasons.

[5] According to World Intellectual Property Organization (WIPO) data from 2018 to 2022, R&D expenditure per GDP was 3.47 in the US and 3.12 in China, while patent applications per capital was 6.71 in the US and 6.88 in China.

Third, our study contributes to the literature on the informativeness of R&D capitalization. Previous research documents the role of R&D capitalization in shaping the information environment (Chen, Gavious, and Lev 2017; Chung, Hillegeist, Park, and Wynn 2019; Mohd 2005), guiding corporate investment decisions (De Waegenaere, Sansing, and Wielhouwer 2017; Oswald, Simpson, and Zarowin 2022; Seybert 2010), affecting equity valuation (Cazavan-Jeny and Jeanjean 2006; Lev, Nissim, and Thomas 2007; Oswald 2008; Oswald, Simpson, Zarowin 2017), and influencing debt contracting (Kreß, Eierle, and Tsalavoutas 2019; Shi 2003). Our work is closely related to the research that focuses on the value relevance of R&D capitalization. While existing studies, utilizing diverse settings and methodologies, produce mixed findings, our research confirms the value relevance of R&D capitalization. Moreover, we introduce new insights, suggesting that the value relevance of R&D capitalization only holds when R&D human capital investment, and thus, quality is high.

Fourth, we contribute to the literature on R&D personnel. Economic theories model a firm's research outcomes as a function of its labor input (Aghion, Bloom, Blundell, and Griffith 2005; Mansfield 1980). Numerous studies underscore the crucial role of R&D labor in shaping firms' research achievements (Arora and Gambardella 1990; Cohen and Levinthal 1990). However, empirical investigations into the effects of R&D labor have been limited, mainly due to the scarcity of detailed data. While some scholars have turned to governmental or industrial surveys to get data on R&D labor (Mowery 1983; Kim and Marschke 2005), the resulting data are often at an aggregate industry or regional level, and lack granularity at the firm-level. Two notable exceptions are the work of Lerner and Wulf (2007) and Yanadori and Cui (2013). They use confidential compensation survey data collected by consulting firms to get information on R&D labor compensation, and find supportive evidence that R&D labor compensation drives innovation success. Our study complements their research by extending the role of R&D labor to the context of R&D capitalization, an alternative indication of firms' research success.

Furthermore, the FASB is currently considering ways to improve R&D accounting, including its disclosure. Our results suggest that requiring firms to disclose R&D labor costs might be beneficial.

Finally, we contribute to the literature on the real effects of disclosure and innovation. At the firm-level, Zhong (2018) finds that disclosure transparency boosts R&D effort by alleviating managers' career concerns and improves R&D efficiency through better monitoring. However, the latter benefit is fully offset by proprietary costs. Kim and Valentine (2021) find that mandatory patent disclosure under the American Inventor's Protection Act (AIPA) hurt disclosing firms' innovation due to proprietary costs, but benefit peer firms' innovation through information spillover. That is, the real effects of R&D disclosure regulation at the firm-level are nuanced. At the aggregate or economy-wide level, Breuer, Leuz, and Vanhaverbeke (2020) find in European settings that mandatory financial report disclosures do not affect total innovation spending, although they do reduce the number of innovative firms. Our finding suggests that mandatory R&D disclosure in China appears to improve firms' R&D level and quality. In this regard, we answer the call by Leuz and Wysocki (2016) to provide more evidence on the real effect of disclosure mandates and echo past research that mandatory disclosure can enhance resource allocation efficiency (e.g., Cho 2015).

2. Institutional Background

2.1 Accounting for R&D

R&D activities play a crucial role in a firm's success and survival and have a significant influence on a country's economic growth (Mowery 1983; Romer 1990). Given the profound impact of R&D activities, accounting standard setters have paid particular attention to how R&D should be accounted for. However, establishing the accounting rules for R&D activities is particularly challenging for standard setters. First, R&D covers a broad range of activities, from basic research to applied research and development. The vast array of these activities leaves standard setters wondering at what point, if any, an economic resource emerges during these activities. Second, R&D activities are inherently risky. While firms might invest significant amounts in R&D, the outcomes of such investments can be uncertain, taking years to materialize, if at all. U.S. standard setters are concerned about the uncertainty of the future economic benefits of R&D costs and wonder whether these expenditures could satisfy asset recognition criteria under U.S. GAAP, which require future economic benefits.

The FASB deliberated on alternative accounting methods for R&D costs before mandating the accounting rules for R&D. They considered options to expense the costs, capitalize them, capitalize them if specific conditions are met, or accumulate them in a specialized category until future benefits are identified. The FASB eventually mandated that all R&D costs be treated as expenses in the period they occur. However, software development is a noteworthy exception. The FASB provides a more flexible approach for software development, permitting firms to capitalize these costs when they meet specific conditions. From the FASB's perspective, software development, unlike many other R&D expenditures, often results in a product with clear potential for future economic benefits. However, the distinct accounting treatment for software development costs has drawn criticism from practitioners due to a potential lack of comparability in financial statements across industries. These criticisms reflect the challenges faced by standard setters in establishing universally accepted accounting rules for R&D.

The FASB's primary concern with capitalizing R&D is the inherent uncertainty surrounding the economic benefits that R&D investments might produce. The FASB supported their full-expensing decision by referencing academic research that finds little or no correlation between R&D expenditures and future sales or earnings. However, some researchers subsequently find that R&D investments can lead to future economic benefits. For example, Lev and Sougiannis (1996) find that capitalizing R&D enhances the association between accounting numbers and stock values. Eberhart, Maxwell, and Siddique (2004) show that firms spending more on R&D often outperform in the long run. Additionally, Chan, Lakonishok, and Sougiannis (2001) and Kothari, Laguerre, and Leone (2002) collectively indicate that while the market may undervalue R&D initially, firms with more R&D investments experience enhanced future returns and earnings growth.

The mixed evidence on R&D's future economic benefits highlights the empirical challenges researchers face when assessing the potential returns on R&D investments. Unlike managers, who have access to private information about the potential future benefits of R&D activities and their likelihood of realization, researchers lack this precise information. This influences their ability to capture future economic benefits in their research designs. Different researchers use different assumptions about R&D's economic potential. Some researchers assume the economic benefits will materialize in the short term, whereas others assume they will be realized in the long run. In addition, it is not clear to researchers what are the best ways to capture these economic benefits. Will the economic benefits manifest in increased sales or enhanced market share? Given these challenges, it seems managers are better positioned to evaluate the future economic benefits of R&D. They possess better information about when, where, and how these benefits might materialize.

The IASB uses a different approach for R&D accounting, recognizing the unique insights managers possess over external observers in assessing the potential economic benefits of R&D. Under IFRS guidelines, R&D is categorized into two stages: research and development. While costs from the research stage must be expensed, those from the development stage can be capitalized if certain criteria are met. Specifically, managers can capitalize the R&D if they can ensure its technical feasibility, express an intent for its use or sale, anticipate its probable future economic benefits, have the necessary resources for completion, and be able to measure its expenditures reliably.[6]

While the IFRS permits managerial judgement in assessing R&D potential, this approach has raised concerns among practitioners. Specifically, allowing managers the flexibility to decide on R&D capitalization based on certain criteria may lead to arbitrary capitalization decisions. This discretion can open the door to potential earnings manipulation. Furthermore, different managers might apply the capitalization criteria in varied ways, resulting in inconsistent reporting practices across firms. Such concerns could compromise the transparency and comparability that the IASB aims to achieve.

From the discussions above, it is clear that the FASB and the IASB have distinct approaches to R&D capitalization. While the FASB prohibits R&D capitalization and offers no room for managerial discretion, the IASB acknowledges the unique roles of managers, allowing them to use their judgment in R&D capitalization. It would be of interest to the FASB to understand how managers would capitalize R&D if they were given the flexibility. Would managers engage in aggressive R&D capitalization if accounting standards allowed it? Would they capitalize R&D for legitimate reasons? Answering these questions empirically is challenging due to the limited R&D disclosures by firms. In our study, we utilize unique R&D disclosure requirements in China to examine these questions.

2.2 China's Unique R&D Disclosure

Without a regulatory mandate for R&D disclosure, it is difficult for researchers to obtain granular and standardized data on R&D. First, firms have strong incentives to withhold their R&D information to safeguard their proprietary information (Hirschey and Weygandt 1985;

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[6] The specific conditions for capitalizing R&D costs are set forth in IAS 38 Intangible Assets (Paragraph 57): (a) the technical feasibility of completing the intangible asset so that it will be available for use or sale, (b) its intention to complete the intangible asset and use or sell it, (c) its ability to use or sell the intangible asset, (d) how the intangible asset will generate probable future economic benefits (i.e., the entity can demonstrate the existence of a market for the output of the intangible asset or the intangible asset itself or, if it is to be used internally, the usefulness of the intangible asset), (e) the availability of adequate technical, financial and other resources to complete the development and to use or sell the intangible asset, and (f) its ability to measure reliably the expenditure attributable to the intangible asset during its development.

Hall and Lerner 2010; Lev, Nissim, and Thomas 2007; Mansfield 1985). They may be concerned that disclosing detailed R&D information could expose proprietary or sensitive details about ongoing projects or future plans, potentially offering competitors an edge. Second, disclosing detailed R&D information might lead to increased volatility in reported earnings, particularly if R&D investments vary from year to year (Healy and Palepu 2001). Firms might prefer not to draw undue attention to these fluctuations. Third, there is a possibility that investors, analysts, or regulators might misinterpret the R&D disclosure, which could result in undesirable stock price movements or regulatory attention (Aboody and Lev 1998; Barth, Kasznik, McNichols 2001). For these reasons, researchers often find that firms tend not to disclose R&D as a separate item on the income statement, provide limited information in the notes to financial statements, or offer varied and less comparable discussion in the financial statements (Aboody and Lev 2000; Koh and Reeb 2015).

China offers a unique opportunity to study R&D capitalization due to its disclosure mandate on R&D-related information. From these mandates, we can access R&D details that are not readily available in other settings. Starting in 2015, the China Security Regulatory Commission (CSRC) mandated public firms to enhance their R&D investment disclosures.[7] Specifically, firms are now required to disclose the number of R&D personnel, the total R&D investment for the year, and the percentage of R&D investments that are capitalized. Further, in 2018, the Ministry of Finance required public firms to disclose R&D expense as a separate item on the income statement.[8] R&D expenses, as well as their components, became available in financial statements from 2018 onwards.

These R&D disclosure mandates provide a unique setting for studying R&D capitalization for several reasons. First, the disclosure requirement provides detailed and comparable

[7] The disclosure mandate can be found in the document issued by CSRC titled, "Publicly Issued Securities Company Information Disclosure Content and Format Standard No. 2 - Content and Format of Annual Reports," revised in 2015.
[8] The disclosure mandate can be found in the document issued by the Ministry of Finance, "Notice on the Revision and Issuance of the 2018 Financial Statement Format for General Enterprises."

information about R&D capitalization among *all* publicly listed firms. This level of granularity is unparalleled, allowing us to derive a more precise image of firms' R&D capitalization. In other settings, researchers often resort to inference based on limited or indirect information of R&D capitalization. For example, Aboody and Lev (1998) study R&D capitalization in the setting of the U.S. software industry where firms are allowed to capitalize R&D but are not mandated to disclose R&D capitalization. They compute R&D capitalization intensity based on software firms' selective disclosure of capitalization amounts. Osward (2008) explores R&D capitalization in the setting of the pre-IFRS period of the U.K., where the existence of R&D capitalization is inferred from firms' disclosure of intangible asset or its amortization. With limited data on R&D capitalization, researchers often find themselves in the position where they can at best infer the existence of R&D capitalization and at most estimate R&D capitalization amounts for a specific industry.

Moreover, our analysis of R&D capitalization also benefits from the disclosure mandate of separately presenting R&D expenses in the income statement. This mandate facilitates the identification of companies actively involved in R&D activities versus those that are not. Such identification is particularly crucial when firms report zero R&D capitalization. In such instances, it can be challenging to determine whether these firms are indeed capitalizing zero R&D costs or simply do not engage in R&D activities. Therefore, the separate reporting of R&D expenses on the income statement ensures that our analysis of R&D capitalization pertains to firms that indeed incur some level of R&D costs. Distinguishing between R&D capitalizers and expensers, or computing the capitalization ratio is only meaningful when such analysis is done within firms with R&D investments. Furthermore, the disclosure of R&D expense components in the financial statement notes provides valuable information about R&D labor input, widely recognized as a key driver behind firms' research success.

While the importance of R&D labor is widely recognized among researchers, data related to R&D labor is often not readily available. Some researchers rely on government statistics to obtain data on R&D labor (Kim and Marschke 2005; Mowery 1983). For instance, the U.S. Bureau of Labor Statistics provides labor data for various occupations. However, such data is typically available at the industry and regional levels, rather than at the firm level. Other researchers may have access to confidential compensation survey data collected by consulting firms (Lerner and Wulf 2007; Yanadori and Cui 2013). Nevertheless, such survey data can suffer from sampling bias if the sample chosen is not representative of the entire population.

Overall, China's R&D disclosure mandates allow us to uniquely address important research questions. First, these mandates enable us to assess the R&D capitalization status among all listed companies. These statistics provide insights into the prevalence of R&D capitalization among firms and the extent to which they capitalize their R&D costs. This sheds light on how aggressively managers make R&D capitalization decisions within the boundary of accounting standards. Second, these disclosure requirements enable us to determine whether R&D capitalization is responsive to its labor input. Meaningful R&D capitalization, as indicated by the standard production function in economics, implies that R&D capitalization should be responsive to its labor input. Third, the disclosure requirements allow us to revisit previous research on the determinants of R&D capitalization and examine whether R&D capitalization is driven by legitimate reasons or a desire to avoid expenses. Finally, these disclosures allow us to evaluate the value relevance of R&D capitalization, adding to mixed findings in past research.

3. Research Design

3.1 Key Variables

3.1.1 R&D Capitalization

We use two measures for the extent to which firms capitalize their R&D costs. The first variable, *CAPITALIZER*, is an indicator variable equal to one if a firm reports non-zero R&D capitalization, indicating that the firm capitalizes any amount of R&D costs. It equals zero when a firm discloses zero R&D capitalization yet still reports non-zero R&D expenses, suggesting that the firm expenses all of its R&D costs. The second variable, *CAPRATIO*, is a continuous measure of R&D capitalization and is defined as the ratio of capitalized R&D costs to total R&D costs. This ratio-based measure captures the extent of capitalization. In robustness tests, we calculate R&D capitalization over the market value of equity, following Lev and Sougiannis (1996), and consider other ratio-based measures, such as capitalization scaled by total assets.

3.1.2 R&D Quality

As previously discussed, we predict that firms' R&D labor cost serves as a signal of their R&D program quality for two primary reasons. First, intensive R&D labor investment signals managers' strong commitment to R&D success because these managers are investing in R&D human capital which can benefit firms' R&D success in the long run. Second, intensive R&D labor investment helps managers attract and retain more talented and skilled labor force who can make meaningful and continuous contribution to firms' R&D success.

Firms' expensed R&D labor compensation is readily available in the notes to financial statements. We estimate the total amount of R&D labor cost by calculating the proportion of total R&D expenses comprised of labor costs, and assuming that the capitalized R&D maintains the same labor input ratio. Moreover, because the total number of R&D employees is also required to be disclosed, we calculate the amount of compensation paid to the average R&D worker. Following the compensation literature, we take the natural logarithm of this average R&D worker's compensation and assign this value to the variable *RDLABOR*. The variable *RDLABOR* captures a firm's investment in R&D labor and is our proxy for R&D

quality. In subsequent analysis, we perform several tests to validate that this measure serves as a valid proxy for R&D quality.

3.2 Regression model

We estimate an Ordinary Least Squares (OLS) regression model to test the association between R&D labor costs and R&D capitalization. We include important determinants of R&D capitalization, as identified in studies by Aboody and Lev (1998), Oswald (2008), and Oswald, Simpson, and Zarowin (2022). The regression model is specified as follows:

$$CAPITALIZATION_{it} = \alpha_0 + \alpha_1 RDLABOR_{it} + \alpha_2 EARNVAR_{it} + \alpha_3 EARNSIGN_{it} + \alpha_4 SIZE_{it} + \alpha_5 MB_{it} + \alpha_6 RD_{it} + \alpha_7 LEV_{it} + \alpha_8 BETA_{it} + \alpha_9 AGE_{it} + \alpha_{10} RDGROWTH_{it} + \delta_i + \tau_t + \varepsilon_{it}, \quad (1)$$

Where *CAPITALIZATION* represents managers' decisions on R&D capitalization regarding whether to capitalize R&D (*CAPITALIZER*) or the ratio of R&D capitalization (*CAPRATIO*). *RDLABOR* serves as a proxy for R&D quality, and represents R&D labor cost as defined above. The coefficient of primary interest in this regression is α_1, indicating how R&D quality is related to R&D capitalization. The direction (positive or negative) of $\alpha_1$reveals whether R&D capitalization is associated with higher R&D quality.

We include a series of variables identified by past research known to influence R&D capitalization (Aboody and Lev 1998; Oswald 2008; Oswald, Simpson, and Zarowin 2022). First, we include earnings variance, *EARNVAR*, defined as the three-year backward-rolling variance of earnings per share scaled by the beginning of year stock price. This measure captures the variability of the firm's earnings over the past three years. A higher variance indicates that earnings are less predictable and, thus, riskier. Its association with R&D capitalization is not clear. On the one hand, firms with higher earnings variability have greater incentives to capitalize R&D to signal their success in R&D (Oswald 2008). On the other hand, such firms' R&D investments are inherently risky, which may preclude their R&D costs from being capitalized (Aboody and Lev 1998).

Second, we include *EARNSIGN* as an indicator variable set equal to one if a firm's earnings are positive, and zero otherwise.[9] The expected association between profitability and R&D capitalization is ambiguous. On the one hand, firms with high profitability may have a reduced incentive to capitalize R&D, as such capitalization could be perceived as a sign of earnings manipulation (Aboody and Lev 1998). On the other hand, firms with strong financial performance are better positioned to capitalize R&D, given their greater financial resources to foster R&D success.

Third, we include *SIZE* to capture the impact of firm size, measured as the natural logarithm of the market value of equity. Its association with R&D capitalization is not clear. On the one hand, large firms may prefer to expense R&D for two main reasons. First, large firms are subject to high political costs and may choose to report increased R&D expense in an effort to lower reported profits (Daley and Vigeland 1983). Second, large firms tend to invest more in basic research, resulting in more R&D costs that are expensed (Aboody and Lev 1998). On the other hand, large firms might be more successful in developing and commercializing R&D initiatives, making their R&D costs more qualified for capitalization.

Fourth, we include *MB* to measure firm growth, which is the market value of equity divided by the book value of equity. It is not clear how firm growth is associated with R&D capitalization. On one hand, high-growth firms face more financial constraints (Eierle and Wencki 2016). Hence, these firms have less capacity to capitalize R&D due to their lack of resources in R&D success. On the other hand, high-growth firms have a stronger incentive to signal their competence through capitalizing R&D due to their reliance on external financing (Eierle and Wencki 2016).

[9] We convert earnings, book value of equity, and total assets to an as-if-expense basis, following Oswald (2008) and Oswald, Simpson, and Zarowin (2022); see the Appendix for details. The results are unchanged if instead we use raw values.

Fifth, we include firms' R&D intensity, *RD*, measured as total R&D expenditures scaled by total assets. The relationship between R&D intensity and R&D capitalization is not clear. On the one hand, due to economies of scale, firms that invest more in R&D should have a more successful R&D program, resulting in greater R&D capitalization (Aboody and Lev 1998). On the other hand, firms with more intensive R&D have less incentive to signal their R&D success via capitalization because they can present their R&D success through other disclosure channels (Oswald 2008). Moreover, R&D-intensive firms are inherently risky. They may be reluctant to capitalize R&D to avoid large impairment write-offs in case of R&D project failure.

Sixth, we include firms' leverage ratio in the regression. *LEV* is the debt-to-equity ratio, defined as total liabilities over total equity. We make no prediction for the coefficient on leverage. On the one hand, highly leveraged firms have a strong incentive to capitalize R&D if they want to boost their earnings to avoid debt covenant violations (Aboody and Lev 1998; Daley and Vigeland 1983; Eierle and Wencki 2016; Oswald 2008; Oswald, Simpson, and Zarowin 2022). On the other hand, highly leveraged firms are under more intense monitoring by creditors, who might push them toward more conservative R&D capitalization (Wang, Xie, and Xin 2018).

Seventh, we include *BETA* to control for firm risk. It is not clear how firm risk is associated with R&D capitalization. On the one hand, riskier firms face more binding financial constraints. Hence, they have more incentive to capitalize R&D to signal their growth potential to capital providers. On the other hand, riskier firms operate in a more volatile environment, and their R&D outcomes can be more uncertain. For this reason, their R&D costs can be less qualified for capitalization.

Eighth, we control for firm age. *AGE* is measured as the natural logarithm of the number of years since the firm was established. We make no prediction for the coefficient on firm age. On the one hand, young firms are subject to high information asymmetries and financial constraints. Therefore, they have a stronger incentive to capitalize R&D to signal their R&D potential to the market. On the other hand, young firms have fewer resources and a lower capacity to conduct successful R&D. Thus, R&D capitalization in such firms can be low.

Ninth, we include *RDGROWTH* to capture firms' R&D status, defined as the change in R&D expenditure over the previous year. The relationship between R&D growth and R&D capitalization is unclear. On the one hand, high R&D growth signals a firm's commitment to R&D breakthroughs. Such firms might run a more successful R&D program and thus be more capable of capitalizing their R&D costs. On the other hand, firms with high R&D growth might devote more resources to basic research, which could result in a lower R&D capitalization ratio.

Finally, we include firm fixed effects (δ_i) to control for time-invariant firm characteristics and year fixed effects (τ_t) to account for secular trends. We cluster standard errors by the firm to control for serial correlation of error terms at the firm level. In robustness tests, we assess the sensitivity of our results to re-estimating the model with alternative fixed effects and clustering approaches.

4. Results

4.1 Data and Sample

We acquire R&D-related data from the China Stock Market and Accounting Research (CSMAR) Database, which includes information on R&D capitalization, R&D expense along with its components, and the number of R&D personnel. Data on patent applications and grants are sourced from the Chinese Research Data Services (CNRDS) Platform. Firm-level financial and stock market data are also obtained from the CSMAR Database. Management's Discussion and Analysis (MDA) textual data are extracted from the CNRDS platform.

Our sample period spans from 2017 to 2021. Beginning in 2018, firms are required to disclose R&D expense in the income statement and their components within the notes to the financial statements. Because the annual reports of listed companies include information from the previous year, we are able to obtain the data for 2017 from the annual reports published for 2018. Our initial sample consists of all the firms listed on the Shanghai Stock Exchange and the Shenzhen Stock Exchange from 2017 to 2021. We screen the initial sample as follows. First, we exclude firms that are subject to special treatment (ST).[10] Second, we exclude firms in the financial industry due to their differential regulatory environment. Third, we exclude observations with missing R&D information to ensure that our sample firms are those engaging in any R&D. Fourth, we exclude observations with missing data for other variables. This sample selection process results in a final sample of 11,692 firm-year observations representing 3,018 unique firms. Table 1 presents the detailed sample selection process. To mitigate the effect of outliers, we winsorize all continuous variables at the 1st and 99th percentiles.

4.2 Descriptive Statistics

Table 2, Panel A presents summary statistics for the variables used in our main regression. The mean value for the R&D capitalization ratio (*CAPRATIO*) is 7%. This finding suggests that, on average, firms capitalize a small portion of their R&D expenditures. The mean value of *CAPITALIZER* is 0.29, revealing that about 29% of firm-years capitalize their R&D costs. These results suggest that when firms have the discretion to capitalize R&D under IFRS, they do not capitalize significant R&D costs. The mean value for R&D labor cost (*RDLABOR*) is 11.674. This number suggests that the average compensation paid to R&D labor force for the average firm equals 117,476 Chinese Yuan (approximately 17,613 US dollars). This mean compensation level paid to the average R&D worker in our sample is slightly higher than compensation levels reported for the average Chinese employee in prior research, suggesting R&D employees command higher wages than average.[11]

[10] Chinese listed firms that report losses for two consecutive years are subject to special treatment (ST). Firms under ST are required to delist if they report losses for a third consecutive year.

[11] Our variable for average R&D labor costs equals $e^{11.674} - 1 = 117{,}476$, which corresponds to 17,613 US dollars given that the exchange rate of the US dollar to the Chinese yuan was approximately 6.67 on December 31, 2019. Lu and Niu (2022) report that the natural logarithm of average employee compensation is equal to 11.50, corresponding to 97,367 Chinese Yuan (approximately $14,598 US dollars). The relatively higher compensation earned by the average R&D worker suggests that R&D personnel, on average, earn premium wages due to their specialized human capital.

Table 2, Panel B compares the mean values of the regression variables between firms that capitalize any amount of R&D costs (i.e., capitalizers) and those that fully expense these costs (i.e., expensers). The comparisons suggest that capitalizers invest more heavily in R&D labor than full expensers do. To the extent that R&D labor costs proxy for quality, this finding suggests that firms capitalizing their R&D costs are engaging in higher-quality R&D activities, and provides initial evidence that firms' R&D capitalization is of high quality. In addition, capitalizers are characterized by lower profitability, larger size, greater R&D intensity, higher leverage, greater systemic risk, longer operational history, and higher R&D growth. These comparisons provide preliminary evidence that capitalizers are more committed to R&D than full expensers.

Table 2, Panel C presents the annual distribution of the R&D capitalization ratio (*CAPRATIO*). The average R&D capitalization ratio indicates overall stability, albeit with a slight decline from 8% to 6% over the years. Nevertheless, these yearly values cluster around the mean value of 7%. Table 2, Panel D provides the industry distribution of the R&D capitalization ratio (*CAPRATIO*), with industry definitions based on the one-digit China Securities Regulatory Commission (CSRC) industry classification codes. The statistics reveal variation in R&D capitalization ratios across industry. Of the 17 industries in our sample, the information and technology industry shows the highest average capitalization ratio at 13%, while the construction industry presents the lowest at 1%. These statistics suggest that firms, regardless of the industries they operate in, tend to capitalize only a small portion of R&D costs when given the discretion to do so.

Table 3 presents the Pearson and Spearman correlation matrix for the variables used in our main regression. R&D labor cost (our proxy for R&D quality) is positively correlated with both the likelihood of R&D capitalization (*CAPITALIZER*) and the R&D capitalization ratio (*CAPRATIO*). These correlations provide preliminary evidence that firms are more likely to capitalize, and capitalize to a greater extent, when their R&D programs are of higher quality. Furthermore, because the correlation coefficients between all pairs of variables are below 0.3, multicollinearity does not appear to be a concern.

4.3 Validation Tests of R&D Labor as a Proxy for Quality

In this section, we verify whether R&D labor costs serve as a signal of a firm's R&D quality. Our first validation test links R&D labor costs to managerial myopia. We posit that managers who invest heavily in R&D labor are less likely to cut R&D expense. Our prediction is based on the premise that substantial resource allocation to R&D personnel reflects managers' dedication to long-term R&D success (Citron 1992; Klingebiel and Rammer 2014). Such a long-term commitment makes it less likely that managers cut R&D for short-term gains (Baber, Fairfield, and Haggard 1991; Bushee 1998; Dechow and Sloan 1991; Graham, Harvey, and Rajgopal 2005).

Past research suggests that managers may intentionally cut R&D to enhance short-term earnings if their R&D expenses does not grow in proportion to sales and operating expenses (e.g., John, Lang, and Netter 1992; Mande, File, and Kwak 2000; Roychowdhury 2006). Thus, we consider managers to have engaged in myopic R&D cuts when R&D expenses in relation to sales or operating expenses fall below previous year levels. Table 4 reports the results for our first validation test. We find a negative and significant association between R&D labor cost and managers' likelihood of cutting R&D across both specifications. This finding suggests that managers' heavy investment in R&D labor signifies their intention to achieve high quality R&D outcomes over the long run.

Our second validation test links R&D labor costs to R&D worker talent and retention. We posit that high compensation paid to R&D labor is indicative of the competence and stability of a firm's R&D labor force. This prediction is based on research in labor economics. Specifically, high compensation attracts more talent (Holzer, Katz, and Krueger 1991; Dal Bó, Finan, and Rossi 2013), incentivizes employees to work harder (Shapiro and Stiglitz 1984), and retains employees within the firm (Bender, Bloom, Card, Van Reenen, and Wolter 2018). Therefore, when R&D personnel are highly compensated, it reflects their skills, knowledge, expertise, work morale, and job satisfaction, which are all crucial to firms' R&D success (Cohen and Levinthal 1990; Griliches 1979; Michie 2003; Romer 1990).

Past research in the economics literature claims that the skills of R&D labor manifest in patents (Acs and Audretsch 1988; Diamond 2016). Hence, we use current patent applications and future patent grants to measure the competence of R&D labor. Unlike past research on executive turnover, where the joining and leaving of executives can be easily identified, we do not have specific data on the inflow and outflow of the R&D labor force. Instead, we use the absolute percentage change in the R&D workforce to measure the retention of the R&D workforce. A similar measure of personnel change can be seen in past research (e.g., Helmich and Brown 1972). A higher value of this measure indicates a larger change in the number of R&D personnel, suggesting less retention of the R&D workforce. Table 5 reports the results for our second validation test. We find that R&D labor costs are positively associated with both current patent applications and future patent grants. We also find that R&D labor costs are negatively associated with R&D personnel changes. These results imply that higher compensation for R&D workers reflects their competence and stability, and ultimately innovation quality. Collectively, these validation tests support R&D labor costs as a proxy for R&D quality. Specifically, high compensation paid to R&D labor is indicative of the intention and capacity for R&D success, signaling that R&D investment is of higher quality.

4.4 Main Result

Table 6 presents the results of estimating the model specified in Equation (1). Specifically, we regress the propensity to capitalize R&D (*CAPITALIZER*) and the ratio of R&D capitalization (*CAPRATIO*) on R&D labor costs (*RDLABOR*) and other determinants in

Columns (1) and (2), respectively. The results show a consistently positive and statistically significant association between R&D labor costs (*RDLABOR*) and both dependent variables at the one percent significance level. These findings suggest that firms with higher R&D labor costs tend to capitalize more of their R&D costs. As shown in Table 7 (where we report the standardized coefficients for the regression variables), a one-standard-deviation increase in R&D labor cost is associated with a 12% standard-deviation increase in the R&D capitalization ratio. Therefore, the association between R&D labor costs and R&D capitalization is both statistically significant and economically meaningful. The implication is that the amounts capitalized in R&D represent high quality R&D efforts.

The coefficient estimates on control variables reveal several important findings compared to past research. First, we find a negative and significant association between earnings variance (*EARNVAR*) and R&D capitalization. This contrasts with Oswald (2008)'s finding, which finds a positive and significant association. Furthermore, Oswald, Simpson, and Zarowin (2022) find an insignificant association. Our finding of a negative coefficient associated with earnings variance indicates that greater unpredictability in earnings indicates a highly uncertain environment. This increased uncertainty can lead to more unpredictable R&D outcomes for firms, thereby diminishing their ability to capitalize R&D investments. This finding is consistent with the argument in Aboody and Lev (1998) that firm risk precludes R&D capitalization.

Next, we observe a negative and significant coefficient on firm profitability (*EARNSIGN*). This coefficient is negative and significant in Aboody and Lev (1998) and Oswald (2008), but it is negative and insignificant in Oswald, Simpson, and Zarowin (2022). Our result is consistent with most findings in prior studies, and suggests that loss firms capitalize larger amounts of R&D.

Notably, we find a positive and significant coefficient on firm size (*SIZE*), which is inconsistent with the findings of Oswald (2008), Oswald, Simpson, and Zarowin (2022), and Aboody and Lev (1998).[12] Our finding of a positive association between firm size and R&D capitalization is consistent with the notion that larger firms, with more resources and capacity to develop and commercialize R&D, tend to have a higher R&D capitalization ratio.

Moreover, we find a negative and significant coefficient on firm growth (*MB*). Oswald (2008) finds a positive yet insignificant coefficient on the market-to-book ratio, while Oswald, Simpson, and Zarowin (2022) find a negative yet insignificant coefficient on it. Our findings support the notion that high-growth firms have lower capacity to capitalize R&D due to their financial constraints.

Importantly, we find that R&D intensity is positively associated with R&D capitalization. As previously discussed, prior research finds mixed evidence for this important economic determinant of R&D capitalization. Aboody and Lev (1998) find a positive and significant coefficient on R&D intensity, while Oswald (2008) and Oswald, Simpson, and Zarowin (2022) find a negative and significant coefficient. Our findings support the finding of Aboody and Lev (1998) that R&D-intensive firms benefit from economies of scale and are more likely to succeed in R&D. R&D-intensive firms thus have a higher level of R&D capitalization.

Regarding firm leverage (*LEV*) and systematic risk (*BETA*), our findings are consistent with those in prior research (Aboody and Lev 1998, Oswald 2008, and Oswald, Simpson, and Zarowin 2022). Specifically, highly leveraged firms have more incentives to capitalize R&D to boost earnings. However, there is no evidence that firm's systematic risk (*BETA*) is associated with R&D capitalization.

[12] Aboody and Lev (1998) report a negative coefficient for firm size. This negative association might be attributable to the mechanical relationship between firm size (measured by market capitalization) and R&D capitalization (measured as capitalized R&D over market capitalization). In Table 8, Panel D, where we use market capitalization as the deflator for R&D capitalization, we replicate their finding of a negative coefficient for firm size. However, when using other deflators for R&D capitalization, the coefficient on firm size is consistently positive. This suggests that the underlying economic relationship between firm size and R&D capitalization should be positive rather than negative.

The last, but not least, important economic determinant of R&D capitalization is firms' R&D status (*RDGROWTH*), as proposed by Oswald (2008) and Oswald, Simpson, and Zarowin (2022). They find that firms with steady R&D status are less likely to capitalize R&D. Consistent with their findings, we observe that firms exhibiting higher R&D growth capitalize more R&D. This suggests that firms with higher R&D growth are more committed to R&D breakthroughs, making them more capable of capitalizing R&D.

Table 7 reports the standardized coefficient estimates for all regression variables. We compare the economic significance of these regression variables to illustrate how each variable contributes to explaining the variation in R&D capitalization. Importantly, R&D labor cost has the largest standardized coefficient estimate among all the important determinants of R&D capitalization. This finding is consistent with the claim among researchers and practitioners that R&D human capital is the key driver of firms' research success.[13] In addition to R&D labor investment, R&D intensity and firm size are the second and third largest contributors to R&D capitalization. As mentioned above, these two variables reflect firms' capacity to capitalize R&D. This is important because it suggests that the largest driver of firms' R&D capitalization is their capacity to capitalize. While we find some evidence that firms' reporting incentives also explain R&D capitalization, the economic significance of the two variables: firm performance and leverage ratio, is much smaller. Overall, these results suggest that the primary driver of R&D capitalization is firms' capacity to capitalize high quality R&D activity rather than any incentives to manipulate.

To provide further evidence on the extent to which firms' reporting incentives explain R&D capitalization decisions, we include several variables in Table 7 to capture these incentives, even though none of these variables are examined by Aboody and Lev (1998),

[13] For example, Adobe Systems Inc., one of the few top market cap firms in the US software industry to disclose R&D capitalization through amortization, acknowledges that recruiting and hiring software developers are critical to maintaining competitiveness in the marketplace and are directly related to the continued, timely development of new and enhanced offerings and solutions (SEC 2022).

Oswald (2008), or Oswald, Simpson, and Zarowin (2022). First, we include accounting restatements to capture managers' earnings manipulation incentives. Second, we include variables for firms' meeting or beating analyst consensus forecasts or last year's earnings benchmark by one cent to capture managers' incentives to meet benchmarks. Finally, we include internal control deficiencies to capture managers' ability to misreport. Column (2) of Table 7 presents the standardized coefficients of these reporting incentive variables. We find that these variables are neither statistically significant nor economically meaningful, except for internal control deficiency, which is marginally significant. However, its coefficient is negative, suggesting that firms with internal control deficiencies capitalize less R&D, and is inconsistent with a financial reporting motivation for R&D capitalization. In Column (3), we extract the principal component of these reporting incentive variables and find that it is negative and insignificant. These results reinforce our findings that, under IFRS where firms have the discretion to capitalize R&D costs, the primary driver of R&D capitalization is firms' ability to capitalize rather than their incentive to manipulate earnings.

4.5 Robustness Tests

Next, in Table 8 we examine the robustness of our findings. From Panel A to Panel G of Table 8, we re-estimate Equation (1) using alternative levels of fixed effects (Panel A), alternative ways of clustering standard errors (Panel B), alternative estimation methods (Panel C), alternative measures of key variables (Panels D and E), and alternative calculations of independent variables (Panels F and G). Our main findings continue to hold when we replace firm fixed effects with industry fixed effects, when we cluster standard errors at the industry level instead of at the firm level, when we estimate the regressions using Logit or Tobit models instead of OLS, when we use alternative deflators for R&D capitalization and R&D labor costs, when we adjust all independent variables by industry-year to remove industry effects, and when we use ranked values instead of raw values to remove the potential impact of outliers.

4.6 Value Relevance Test

We next explore investor pricing of R&D capitalization. Specifically, we investigate (1) whether and how investors price R&D capitalization and (2) whether this investor pricing varies between firms with high and low R&D quality. We estimate a basic value relevance model following the empirical design in past research (Dhaliwal, Subramanyam, and Trezevant 1999; Louis 2003; Campbell 2015):

$$RET_{it} = \beta_0 + \beta_1 NI_{it} + \beta_2 RDCAP_{it} + \varepsilon_{it}, \quad (2)$$

where *RET* is the raw stock returns compounded over eight months before the fiscal year end to four months after it. *NI* is the reported net income during the fiscal year. *RDCAP* is the capitalized R&D amount for the fiscal year. We scale the right-hand side variables, including the intercept, by beginning-year market value of equity, a common design for value relevance tests. We include firm and year fixed effects in the regression to be consistent with our other tests. The coefficient on *RDCAP*, β_2, indicates whether investors' pricing is associated with capitalized R&D amounts. A positive sign of this coefficient suggests that investors associate higher value for firms with capitalized R&D amounts.

Table 9 reports the results of these tests. In Column (1) of Panel A, the coefficient on net income (*NI*) is significantly positive, consistent with the common finding in past research that earnings are value relevant. We also find a positive and significant coefficient on capitalized R&D amounts (*RDCAP*). This finding suggests that investors pricing is correlated with the capitalized amount of R&D, supporting the value relevance of R&D capitalization. In Columns (2) and (3), we partition our sample based on R&D quality and examine the value relevance of R&D capitalization separately for these two groups. Interestingly, we find that the positive association between investors' pricing and R&D capitalization is significantly stronger for firms with higher R&D quality. In fact, we find no evidence that investors pricing is correlated with R&D capitalization when R&D is of lower quality. More interesting findings emerge from Panel B, where we report standardized coefficient estimates. In Column (1), the economic significance of R&D capitalization is one-third as large as that of earnings. Additionally, the pricing of earnings by investors is almost identical between the two groups. However, there is a sharp difference in the value relevance of R&D capitalization. For firms with high R&D quality, the value relevance of capitalization is almost half that of earnings, whereas for firms with low R&D quality, it is less than one-fifth. This finding suggests that the disclosure of R&D labor provides a signal about investor perceptions of R&D capitalization quality. Because these tests are value relevance in nature, we cannot say with certainty that investors rely on these disclosures to inform the pricing decisions. We can only say that whatever investors use to form prices, it is associated with the disclosure.

4.7 Additional Tests – Real Effects of R&D Disclosure Mandate

Finally, we examine whether the regulation of R&D disclosure in China has real effects on the level or quality of firms' R&D innovation. The 2018 disclosure rule requires all firms to present R&D expense as a separate item on income statement and firms should also disclose R&D components in the notes to financial statements. Specifically, we investigate whether this R&D disclosure mandate has any effect on R&D related outcomes, including R&D disclosure level, R&D investment amount, and R&D quality.

Ex-ante, it is unclear how firms would react to this disclosure mandate. Being forced to disclose detailed R&D information could intensify managers' proprietary concerns. Managers, especially those who have heavily invested in R&D labor previously, might be discouraged from discussing R&D in voluntary disclosures, or they might even be reluctant to further invest in R&D or to enhance its quality. Another possibility is that managers recognize the information value of R&D disclosure and incorporate the anticipated positive investor reactions into their R&D-related decisions. Consequently, we might observe that managers who have previously invested less in R&D labor respond more to the disclosure mandate by more openly discussing R&D in voluntary disclosures, increasing their investment in R&D, and further improving its quality.

To empirically investigate the impact of the R&D disclosure mandate, we conduct a difference-in-differences (DID) regression analysis. This DID design is feasible because, in the mandate year of 2018, firms were also required to report R&D details for the previous year of 2017. Consequently, we treat the year 2017 as the pre-event year and 2019 as the post-event year. We categorize firms with higher R&D labor costs at the time of the disclosure mandate as the treated group, and the remaining firms as the control group. The findings are presented in Table 10. In Columns (1) – (3), the dependent variables are voluntary R&D disclosure (measured by the R&D-related word count in annual filings), total R&D investment (defined in the same way as R&D labor costs), and R&D quality (measured by R&D labor costs). The key independent variable is the indicator variable *POST*. Our results indicate that, following the disclosure mandate, firms are more likely to mention R&D in their disclosures, increase their investment in R&D, and enhance the quality of their R&D. In Columns (4) – (6), we introduce an interaction between the *TREAT* and *POST* variables. The main effect of *TREAT* is absorbed with the inclusion of firm fixed effects. We observe that firms that previously invested less in R&D labor tend to discuss R&D information more in voluntary disclosures and show a greater improvement in R&D quality post-mandate. These findings suggest that the benefits of disclosure have a positive feedback effect on managers' R&D-related decision-making.

5. Conclusion

Our study benefits from China's regulatory efforts to standardize R&D disclosure, which provides us with granular data on firms' R&D activities that are not observable in other settings. In this regard, we respond to the call by Leuz and Wysocki (2016) for researchers to explore disclosure regulations in countries outside the U.S. for better identification and more novel findings. Although the results documented in our study may not be directly carried over to other countries, they should still be valuable to standard setters worldwide for their cost-benefit analyses when deciding on R&D disclosure mandates.

Our study reveals several findings that may interest regulators, standard setters, and practitioners. First, using standardized R&D capitalization disclosures across the universe of listed firms in a setting where firms largely have discretion to capitalize R&D costs under IFRS, we find no evidence of aggressive R&D capitalization. The fact that many firms do not capitalize R&D, or only capitalize a small proportion, mitigates concerns about overcapitalization. Second, by examining disclosures on R&D labor, we find that firms' investment in R&D labor conveys information about managers' willingness and capacity to innovate. Therefore, the disclosure of R&D labor can potentially benefit investors and other stakeholders by enhancing their understanding of firms' R&D quality. Third, R&D labor costs exhibit a statistically significant and economically meaningful association with capitalized R&D amounts. Furthermore, capitalized R&D amounts are closely associated with firms' capacity to innovate. Hence, firms' R&D capitalization decisions under IFRS with robust disclosure appear to be based more on economic substance than on earnings manipulation. Fourth, the disclosure of R&D labor communicates valuable information about R&D quality, as investors pricing decisions appear to associate strictly with the extent to which capitalized R&D is of higher quality. Lastly, we find no evidence that the disclosure of R&D labor leads to deadweight costs. Instead, the disclosure appears to have real effects by motivating managers to enhance R&D disclosure, levels, and quality.

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Appendix
Variable Definitions

Variables	Definition
Dependent Variables	
CAPRATIO	The ratio of capitalized R&D costs divided by total R&D costs.
CAPITALIZER	An indicator equal to one for firms report non-zero capitalization and zero otherwise.
CAPVAL	The ratio of capitalized R&D divided by market value of equity (in thousands).
CAPASSET	The ratio of capitalized R&D divided by total assets.
CAPSALE	The ratio of capitalized R&D divided by sales.
Key Independent Variables	
RDLABOR	The natural logarithm of one plus total R&D labor cost over the total number of R&D personnel.
RDLABORRD	The natural logarithm of one plus total R&D labor cost over total R&D expenditures.
RDLABORASSET	The natural logarithm of one plus total R&D labor cost over total assets.
RDLABORMV	The natural logarithm of one plus total R&D labor cost over the market value of equity (in thousands).
LOGRDLABOR	The natural logarithm of one plus total R&D labor cost.
Control Variables	
EARNVAR	Three-year backward-rolling variance of *EPS* scaled by beginning stock price.
EARNSIGN	An indicator variable equal to one if earnings for the firm (converted to an as-if-expense basis, which equals the earnings before tax minus the capitalized R&D) is positive, and zero otherwise.
SIZE	The natural logarithm of the market value of equity at the fiscal year end.
MB	The market value of equity divided by the adjusted book value of equity. The adjusted book value of equity equals the book value of equity minus the capitalized R&D.
RD	R&D expenditure scaled by adjusted total assets. Adjusted total assets equal the total assets minus the capitalized R&D).
LEV	Total liability scaled by the adjusted book value of equity. The adjusted book value of equity equals the book value of equity minus the capitalized R&D.
BETA	The firm's CAPM beta.
AGE	The natural logarithm of the number of years since the firm's establishment.
RDGROWTH	The percentage change in R&D expenditure from the previous year.
Validation tests	
CUTRDSALE	Equal to one if firm's R&D expense over sales is below last year's level, and zero otherwise.
CUTRDEXP	Equal to one if firm's R&D expense over operating expense is below last year's level, and zero otherwise.

PATENTAPP	The natural logarithm of one plus the number of patent application per R&D employee.
PATENTGRANT	The natural logarithm of one plus the number of patent grant per R&D employee.
RDRETENTION	The absolute value of percentage change in employee number from the previous year.
Earnings Management Variables	
MBE	An indicator variable equal to one if firm's EPS meet or small beat analyst consensus forecast by one cent, and zero otherwise. Analyst consensus forecast is the mean earnings forecast among all analysts following the firm before earnings announcement.
MBPAST	An indicator variable equal to one if firm's EPS meet or small beat last year's by one cent, and zero otherwise.
RESTATE	An indicator variable equal to one if firm's financial reporting is restated, and zero otherwise.
DEFICIENCY	An indicator variable equal to one if a firm has internal control deficiency, and zero otherwise.
PRINCOMP	The mean value of three principal components (with Eigenvalue greater than one) of all the earnings management variables.
Partition Variables	
HIGHRDLABOR	Equal to one for firm-year observations whose *RDLABOR* is above the industry-year sample median, and zero otherwise.
Variables in Further Analysis	
RET	The raw buy-and-hold 12-month compounded returns over eight months before the fiscal year end to four months after it.
CAP	The capitalized R&D scaled by beginning-year market value of equity.
NI	The net income minus the adjusted capitalized R&D then divided by beginning-year market value of equity. The adjusted capitalized R&D is the capitalized R&D times one minus the firms' statutory tax rates of 25%).
RDWORD	The natural logarithm of one plus R&D related word count in MD&A sections of annual filings.
RDINVEST	The natural logarithm of one plus total R&D expenditures scaled by total number of R&D personnel.
POST	Equals one for the observations in the year 2019, and zero for the observations in year 2017. The shock year 2018 is excluded.
TREAT	Equals one for the firms whose R&D labor costs are above the industry median in the year 2018, and zero otherwise.

Table 1
Sample Selection

	# Obs.	# Unique Firms
The initial sample of A-share listed firms from 2017 to 2021	24,253	5,173
Less:		
Observations that are subject to special treatment (ST)	(680)	(8)
Observations from the financial industry	(530)	(108)
Observations with missing R&D information	(7,746)	(1,072)
Observations with missing data	(3,605)	(967)
Final sample	11,692	3,018

This table shows the sample selection process.

Table 2
Descriptive Statistics

Panel A: Summary Statistics of Key Variables

VARIABLES	N	Mean	SD	Min	P25	Median	P75	Max
CAPRATIO	11692	0.065	0.148	0.000	0.000	0.000	0.029	0.735
CAPITALIZER	11692	0.294	0.456	0.000	0.000	0.000	1.000	1.000
RDLABOR	11692	11.674	0.726	9.155	11.323	11.730	12.117	13.331
EARNVAR	11692	0.002	0.007	0.000	0.000	0.000	0.001	0.050
EARNSIGN	11692	0.850	0.357	0.000	1.000	1.000	1.000	1.000
SIZE	11692	22.645	0.980	21.115	21.920	22.453	23.207	25.698
MB	11692	3.295	2.824	0.527	1.617	2.477	3.888	17.778
RD	11692	0.026	0.021	0.000	0.012	0.022	0.034	0.116
LEV	11692	1.001	1.051	0.068	0.366	0.706	1.233	6.792
BETA	11692	1.090	0.369	0.272	0.850	1.093	1.325	2.100
AGE	11692	2.953	0.277	2.197	2.773	2.996	3.178	3.526
RDGROWTH	11692	0.268	0.616	-0.595	-0.005	0.150	0.355	4.253

Panel B: Mean Difference between Capitalizers and Expensers

	(1)	(2)	(3)
VARIABLES	Mean for Capitalizer	Mean for Expenser	Capitalizer vs Expenser
CAPRATIO	0.222	0.000	0.222***
RDLABOR	11.847	11.602	0.245***
EARNVAR	0.002	0.002	0.000
EARNSIGN	0.792	0.874	-0.082***
SIZE	22.950	22.518	0.432***
MB	3.308	3.289	0.018
RD	0.032	0.023	0.009***
LEV	1.106	0.958	0.148***
BETA	1.127	1.075	0.053***
Age	2.966	2.947	0.019***
RDGROWTH	0.312	0.250	0.062***
N	3,435	8,257	11,692

Panel C: Summary Statistics of Capitalization Ratio by Year

VARIABLES	Year	Obs	Mean
CAPRATIO	2017	1,810	0.083
	2018	2,025	0.075
	2019	2,488	0.062
	2020	2,556	0.058
	2021	2,813	0.056
	Total	11,692	0.065

Panel D: Summary Statistics of Capitalization Ratio by Industry

VARIABLES	Industry Name	Obs	Mean
CAPRATIO	Agriculture, forestry, and fishing	116	0.077
	Mining	155	0.066
	Manufacturing	8,603	0.056
	Utility	177	0.092
	Construction	334	0.013
	Wholesale trade	261	0.088
	Transport	158	0.132
	Lodging	13	0.114
	Information and technology	1,106	0.134
	Real estate	94	0.068
	Services	122	0.093
	Scientific research	169	0.038
	Facility management	151	0.042
	Resident service & Education	22	0.098
	Health and social work	32	0.043

Entertainment	133	0.077
Diversified industry	46	0.098
Total	11,692	0.065

Panel A shows the summary statistics of our main variables. Panel B compares the mean differences in our main variables between capitalizers and expensers. Panel C summarizes the capitalization ratio (*CAPRATIO*) by year. Panel D details the summary statistics of the capitalization ratio (*CAPRATIO*) by industry. Industry definitions are based on the one-digit China Securities Regulatory Commission (CSRC) industry classification codes.

Table 3
Correlation Matrix

	VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
(1)	*CAPRATIO*		0.980***	0.164***	-0.032***	-0.124***	0.206***
(2)	*CAPITALIZER*	0.683***		0.159***	-0.023**	-0.105***	0.210***
(3)	*RDLABOR*	0.127***	0.154***		0.068***	-0.037***	0.203***
(4)	*EARNVAR*	-0.013	0.003	0.031***		-0.344***	0.024**
(5)	*EARNSIGN*	-0.152***	-0.105***	-0.033***	-0.309***		0.177***
(6)	*SIZE*	0.140***	0.201***	0.197***	-0.048***	0.169***	
(7)	*MB*	0.014	0.003	0.110***	0.020**	-0.064***	0.254***
(8)	*RD*	0.121***	0.190***	0.291***	-0.053***	-0.029***	0.078***
(9)	*LEV*	0.045***	0.064***	-0.017*	0.249***	-0.231***	0.038***
(10)	*BETA*	0.043***	0.065***	-0.052***	-0.051***	0.031***	0.011
(11)	*AGE*	0.014	0.030***	-0.001	0.063***	-0.028***	0.025***
(12)	*RDGROWTH*	0.051***	0.046***	0.011	-0.054***	0.084***	0.135***

	VARIABLES	(7)	(8)	(9)	(10)	(11)	(12)
(1)	*CAPRATIO*	-0.008	0.163***	0.087***	0.074***	0.027***	0.042***
(2)	*CAPITALIZER*	-0.015	0.167***	0.094***	0.074***	0.033***	0.043***
(3)	*RDLABOR*	0.117***	0.286***	-0.005	-0.045***	0.007	0.048***
(4)	*EARNVAR*	-0.119***	-0.059***	0.213***	-0.049***	0.059***	-0.065***
(5)	*EARNSIGN*	-0.026***	-0.009	-0.169***	0.017*	-0.022**	0.174***
(6)	*SIZE*	0.139***	0.008	0.113***	0.006	0.046***	0.191***
(7)	*MB*		0.335***	-0.126***	0.143***	-0.150***	0.077***
(8)	*RD*	0.281***		-0.171***	0.153***	-0.122***	0.120***
(9)	*LEV*	0.122***	-0.161***		-0.043***	0.089***	0.023**
(10)	*BETA*	0.090***	0.142***	-0.060***		-0.167***	0.019**
(11)	*AGE*	-0.077***	-0.103***	0.097***	-0.169***		-0.028***
(12)	*RDGROWTH*	0.038***	-0.010	0.055***	-0.002	0.010	

This table presents the correlation matrix. Correlation coefficients above (below) the diagonal are Spearman (Pearson) correlation coefficients. The superscripts *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 4
Validation Test: R&D Labor cost and the Likelihood of Cutting R&D

VARIABLES	(1) *CUTRDSALE*	*CUTRDEXP*
RDLABOR	-0.053***	-0.032**
	(-3.89)	(-2.42)
EARNVAR	-0.787	-2.518***
	(-0.96)	(-2.76)
EARNSIGN	0.156***	-0.128***
	(9.43)	(-7.93)
SIZE	0.034*	-0.017
	(1.92)	(-0.97)
MB	0.011***	0.006*
	(2.77)	(1.76)
RD	-9.393***	-8.449***
	(-12.33)	(-11.97)
LEV	0.010	0.012
	(0.94)	(1.16)
BETA	0.001	-0.043***
	(0.08)	(-2.74)
AGE	0.243	0.159
	(1.29)	(0.91)
RDGROWTH	-0.142***	-0.133***
	(-15.68)	(-15.40)
Constant	-0.432	0.941
	(-0.63)	(1.49)
Year Fixed Effects	Yes	Yes
Firm Fixed Effects	Yes	Yes
N	11,692	11,692
Adj. R-squared	0.165	0.161

This table presents the validation test for our R&D labor cost measure, relating R&D labor cost (*RDLABOR*) to the likelihood of cutting R&D. *T*-statistics, reported in parentheses, are calculated using robust standard errors clustered at the firm level. All variables are defined in the Appendix. The superscripts *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively, in a two-tailed test within the regression.

Table 5
Validation Test: R&D Labor Cost and R&D Worker Talent and Retention

VARIABLES	(1) *PATENTAPP*	(2) *PATENTGRANT*	(3) *RDRETENTION*
RDLABOR	0.063***	0.015***	-0.244***
	(11.10)	(3.47)	(-11.34)
EARNVAR	-0.422	-0.118	1.832**
	(-1.46)	(-0.43)	(2.33)
EARNSIGN	-0.006	-0.002	-0.006
	(-1.44)	(-0.57)	(-0.50)
SIZE	0.002	0.001	0.049***
	(0.38)	(0.33)	(2.69)
MB	-0.001	-0.001	-0.004
	(-0.84)	(-1.35)	(-1.08)
RD	-0.674***	-0.001	-1.978***
	(-3.94)	(-0.01)	(-3.24)
LEV	0.001	0.000	0.015
	(0.31)	(0.09)	(1.32)
BETA	-0.001	-0.006*	-0.011
	(-0.14)	(-1.79)	(-0.79)
AGE	-0.025	-0.032	-0.354*
	(-0.40)	(-0.64)	(-1.85)
RDGROWTH	-0.002	-0.003	0.256***
	(-0.53)	(-1.14)	(16.13)
Constant	-0.513**	0.035	3.040***
	(-2.29)	(0.20)	(4.26)
Year Fixed Effects	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes
N	11,692	11,692	11,634
Adj. R-squared	0.670	0.663	0.287

This table presents the validation test of our R&D labor cost measure by relating R&D labor cost to R&D worker competence (measured as current patent application and future patent grant). *T*-statistics, reported in parentheses, are calculated using robust standard errors clustered at the firm level. All variables are defined in the Appendix. The superscripts *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively, in a two-tailed test within the regression.

Table 6
Main Results

VARIABLES	(1) *CAPITALIZER*	(2) *CAPRATIO*
RDLABOR	0.034***	0.025***
	(3.39)	(5.65)
EARNVAR	-1.961***	-0.988***
	(-3.31)	(-4.07)
EARNSIGN	-0.026***	-0.013***
	(-3.20)	(-3.77)
SIZE	0.073***	0.017***
	(5.63)	(3.93)
MB	-0.013***	-0.003***
	(-4.75)	(-4.00)
RD	1.963***	0.837***
	(4.07)	(4.67)
LEV	0.019***	0.005*
	(2.62)	(1.83)
BETA	-0.002	-0.004
	(-0.21)	(-1.13)
AGE	-0.144	0.029
	(-0.96)	(0.59)
RDGROWTH	0.019***	0.006**
	(3.34)	(2.30)
Constant	-1.326**	-0.685***
	(-2.54)	(-3.71)
Year Fixed Effects	Yes	Yes
Firm Fixed Effects	Yes	Yes
N	11,692	11,692
Adj. R-squared	0.772	0.765

This table reports the association between R&D labor cost and R&D capitalization. *T*-statistics, reported in parentheses, are calculated using robust standard errors clustered at the firm level. All variables are defined in the Appendix. The superscripts *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively, in a two-tailed test within the regression.

Table 7
Standardized Coefficients

VARIABLES	(1) *CAPRATIO*	(2) *CAPRATIO*	(3) *CAPRATIO*
RDLABOR	0.121***	0.121***	0.121***
	(5.65)	(5.67)	(5.66)
MBE		-0.002	
		(-0.30)	
MBPAST		-0.003	
		(-0.59)	
RESTATE		0.006	
		(1.08)	
DEFICIENCY		-0.021*	
		(-1.68)	
PRINCOMP			-0.004
			(-0.65)
EARNVAR	-0.045***	-0.045***	-0.045***
	(-4.07)	(-4.08)	(-4.07)
EARNSIGN	-0.031***	-0.032***	-0.031***
	(-3.77)	(-3.81)	(-3.75)
SIZE	0.110***	0.109***	0.110***
	(3.93)	(3.90)	(3.93)
MB	-0.063***	-0.064***	-0.063***
	(-4.00)	(-4.00)	(-3.99)
RD	0.120***	0.120***	0.120***
	(4.67)	(4.68)	(4.67)
LEV	0.033*	0.033*	0.033*
	(1.83)	(1.86)	(1.83)
BETA	-0.010	-0.010	-0.010
	(-1.13)	(-1.08)	(-1.14)
AGE	0.055	0.055	0.055
	(0.59)	(0.60)	(0.59)
RDGROWTH	0.024**	0.024**	0.024**
	(2.30)	(2.30)	(2.30)
Constant	0.000***	0.000***	0.000***
	(3.01)	(2.75)	(3.00)
Year Fixed Effects	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes
N	11,692	11,692	11,692
Adj. R-squared	0.765	0.765	0.765

This table shows the standardized coefficients of the regression variables. Column (1) presents the standardized coefficients for the main regression variables. Columns (2) presents the standardized coefficients for main regression variables plus all four financial reporting variables. Columns (3) presents the standardized coefficients for main regression variables plus the principal component of all four financial reporting variables. *T*-statistics, reported in parentheses, are calculated using robust standard errors clustered at the firm level. All variables are defined in the Appendix. The superscripts *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively, in a two-tailed test within the regression.

Table 8
Robustness Tests

Panel A: Industry Fixed Effects

VARIABLES	(1) *CAPITALIZER*	(2) *CAPRATIO*
RDLABOR	0.038***	0.015***
	(3.84)	(3.94)
EARNVAR	-2.078**	-1.363***
	(-2.45)	(-5.21)
EARNSIGN	-0.155***	-0.074***
	(-10.55)	(-10.45)
SIZE	0.098***	0.022***
	(12.06)	(7.89)
MB	-0.026***	-0.005***
	(-10.21)	(-5.50)
RD	3.532***	0.601***
	(8.19)	(3.93)
LEV	0.053***	0.011***
	(7.37)	(4.02)
BETA	0.053***	0.007
	(3.26)	(1.31)
AGE	0.063**	0.012
	(2.40)	(1.43)
RDGROWTH	0.024***	0.010***
	(3.38)	(3.58)
Constant	-2.531***	-0.591***
	(-11.99)	(-8.02)
Year Fixed Effects	Yes	Yes
Firm Fixed Effects	No	No
Ind Fixed Effects	Yes	Yes
N	11,692	11,692
Adj. R-squared	0.186	0.148

Panel B: Industry Cluster

VARIABLES	(1) *CAPITALIZER*	(2) *CAPRATIO*
RDLABOR	0.034***	0.025***
	(3.23)	(3.67)
EARNVAR	-1.961***	-0.988***
	(-2.81)	(-3.29)
EARNSIGN	-0.026***	-0.013***
	(-3.14)	(-3.19)
SIZE	0.073***	0.017***
	(4.21)	(2.87)
MB	-0.013***	-0.003***
	(-4.07)	(-3.75)
RD	1.963***	0.837***
	(3.56)	(4.18)
LEV	0.019**	0.005
	(2.09)	(1.55)
BETA	-0.002	-0.004
	(-0.26)	(-1.01)
AGE	-0.144	0.029
	(-0.83)	(0.66)
RDGROWTH	0.019**	0.006**
	(2.60)	(2.29)
Constant	-1.326*	-0.685***
	(-1.83)	(-2.96)
Year Fixed Effects	Yes	Yes

Firm Fixed Effects	Yes	Yes
Cluster	Industy	Industy
N	11,692	11,692
Adj. R-squared	0.772	0.765

Panel C: Alternative Specification

VARIABLES	(1) FF Logit *CAPITALIZER*	(2) FE Tobit *CAPRATIO*
RDLABOR	0.616***	0.039***
	(4.14)	(3.90)
EARNVAR	-39.348***	-1.453**
	(-3.62)	(-2.25)
EARNSIGN	-0.491***	-0.019***
	(-2.67)	(-3.76)
SIZE	1.162***	0.035***
	(5.78)	(4.58)
MB	-0.208***	-0.008***
	(-4.89)	(-3.76)
RD	27.343***	1.082***
	(3.74)	(3.81)
LEV	0.281**	0.013**
	(2.52)	(2.17)
BETA	0.060	-0.002
	(0.30)	(-0.34)
AGE	-1.677	-0.049
	(-0.80)	(-0.44)
RDGROWTH	0.304***	0.006*
	(3.60)	(1.68)
Year Fixed Effects	Yes	Yes
Firm Fixed Effects	Yes	Yes
N	2,076	11,692
Adj./ Pseudo R-squared	0.0942	-

Panel D: Alternative Dependent Variables

VARIABLES	(1) *CAPVAL*	(2) *CAPASSET*	(3) *CAPSALE*
RDLABOR	0.509***	0.503***	1.472***
	(5.04)	(4.58)	(4.33)
EARNVAR	-33.196***	-27.180***	-91.409***
	(-4.88)	(-4.05)	(-4.93)
EARNSIGN	-0.642***	-0.537***	-2.319***
	(-6.55)	(-5.03)	(-6.92)
SIZE	-0.286**	0.544***	1.278***
	(-2.56)	(3.70)	(3.36)
MB	-0.146***	-0.135***	-0.429***
	(-6.81)	(-3.96)	(-4.47)
RD	67.145***	113.333***	229.169***
	(10.18)	(10.79)	(8.69)
LEV	0.216***	0.219***	0.469**
	(2.84)	(2.76)	(2.43)
BETA	-0.069	-0.095	-0.127
	(-0.72)	(-0.94)	(-0.43)
AGE	0.499	0.525	4.803
	(0.47)	(0.32)	(0.93)
RDGROWTH	0.074	0.047	0.177
	(1.55)	(0.68)	(0.98)
Constant	-0.314	-19.917***	-58.386***
	(-0.08)	(-3.25)	(-3.17)
Year Fixed Effects	Yes	Yes	Yes

Firm Fixed Effects	Yes	Yes	Yes
N	11,692	11,692	11,692
Adj. R-squared	0.750	0.806	0.785

Panel E: Alternative Independent Variables

VARIABLES	(1) *CAPRATIO*	(2) *CAPRATIO*	(3) *CAPRATIO*	(4) *CAPRATIO*
RDLABORRD	0.124***			
	(5.23)			
RDLABORASSET		1.152**		
		(2.17)		
RDLABORMV			0.046***	
			(6.94)	
LOGRDLABOR				0.031***
				(6.67)
EARNVAR	-0.958***	-0.975***	-0.791***	-0.785***
	(-3.93)	(-4.00)	(-3.32)	(-3.27)
EARNSIGN	-0.013***	-0.013***	-0.012***	-0.013***
	(-3.86)	(-3.79)	(-3.56)	(-3.68)
SIZE	0.021***	0.019***	0.036***	0.003
	(4.68)	(4.44)	(6.72)	(0.70)
MB	-0.004***	-0.004***	-0.001	-0.001
	(-4.80)	(-4.51)	(-0.99)	(-1.18)
RD	1.262***	0.578**	0.360*	0.479***
	(6.44)	(2.15)	(1.94)	(2.63)
LEV	0.005**	0.005**	0.000	0.000
	(2.20)	(2.08)	(0.05)	(0.18)
BETA	-0.004	-0.004	-0.004	-0.005
	(-1.06)	(-1.03)	(-1.12)	(-1.30)
AGE	0.019	0.023	0.029	0.034
	(0.38)	(0.46)	(0.57)	(0.69)
RDGROWTH	0.008***	0.007***	0.005*	0.004
	(3.31)	(2.73)	(1.89)	(1.60)
Constant	-0.510***	-0.447**	-0.915***	-0.643***
	(-2.89)	(-2.53)	(-4.68)	(-3.57)
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
N	11,692	11,692	11,692	11,692
Adj. R-squared	0.764	0.762	0.767	0.767

Panel F: Industy-year Adjusted Variables

VARIABLES	(1) *CAPITALIZER*	(2) *CAPRATIO*
RDLABOR	0.442***	0.292***
	(3.74)	(5.85)
EARNVAR	-0.007***	-0.003***
	(-3.97)	(-4.91)
EARNSIGN	-0.018***	-0.010***
	(-2.73)	(-3.50)
SIZE	1.864***	0.496***
	(6.39)	(5.10)
MB	-0.055***	-0.017***
	(-5.76)	(-5.69)
RD	0.052***	0.019***
	(4.69)	(3.45)
LEV	0.032***	0.010***
	(3.69)	(3.40)
BETA	-0.002	-0.004
	(-0.21)	(-1.12)
AGE	-0.010	-0.010

	(-0.04)	(-0.11)
RDGROWTH	0.003**	0.001
	(2.00)	(1.39)
Constant	-2.007***	-0.707***
	(-5.20)	(-5.20)
Year Fixed Effects	Yes	Yes
Firm Fixed Effects	Yes	Yes
N	11,691	11,691
Adj. R-squared	0.772	0.765

Panel G: Ranked variables

VARIABLES	(1) *CAPITALIZER*	(2) *CAPRATIO*
RDLABOR	0.071***	0.043***
	(3.19)	(4.96)
EARNVAR	-0.047***	-0.021***
	(-3.87)	(-4.91)
EARNSIGN	-0.011	-0.009***
	(-1.23)	(-3.02)
SIZE	0.171***	0.054***
	(5.58)	(5.02)
MB	-0.102***	-0.041***
	(-4.25)	(-5.20)
RD	0.119***	0.043***
	(4.40)	(3.90)
LEV	0.071***	0.022**
	(2.95)	(2.40)
BETA	0.014	0.002
	(1.37)	(0.58)
AGE	0.035	-0.028
	(0.55)	(-1.05)
RDGROWTH	0.024**	0.009**
	(2.24)	(2.50)
Constant	0.121***	0.029
	(2.88)	(1.64)
Year Fixed Effects	Yes	Yes
Firm Fixed Effects	Yes	Yes
N	11,692	11,692
Adj. R-squared	0.771	0.763

This table reports the robustness tests of our main results. Panel A shows the estimated result of the main regression with the inclusion of industry fixed effects. In Panel B, we calculate *t*-statistics based on robust standard errors clustered at the industry level. In Panel C, we re-estimate the main results with alternative specifications. Panel D reports the results with alternative dependent variables. Panel E shows the results with alternative independent variables. In Panel F, we scale the independent variable and control variables by their industry-year mean values to alleviate the impact of industry-specific factors and time trends. In Panel G, all explanatory variables are measured as the normalized percentile ranking of each firm within its industry-year following Oswald (2008) and Oswald, Simpson, and Zarowin (2022). *T*-statistics are reported in parentheses and calculated based on robust standard errors clustered at the firm level (except for Panel B). All the variables are as defined in the Appendix. The superscripts *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively, in a two-tailed test in the regression.

Table 9
Value Relevance

Panel A: Raw Coefficients

	(1)	(2)	(3)
Dep. Var.		*RET*	
	Full	*HIGHRDLABOR*=1	*HIGHRDLABOR*=0
NI	1.247***	1.237***	1.172***
	(15.68)	(9.38)	(10.90)
CAP	7.962***	9.835***	3.712
	(3.92)	(3.68)	(1.28)
INTERCEPT	17.920***	19.061***	16.458***
	(28.53)	(18.95)	(17.50)
Difference in *NI*		*p*-value = 0.168	
Difference in *CAP*		*p*-value = 0.01	
Year Fixed Effects	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes
N	11,516	5,698	5,818
Adj. R-squared	0.163	0.161	0.154

Panel B: Standardized Coefficients

	(1)	(2)	(3)
Dep. Var.		*RET*	
	Full	*HIGHRDLABOR*=1	*HIGHRDLABOR*=0
NI	0.211***	0.204***	0.205***
	(15.68)	(9.38)	(10.90)
CAP	0.081***	0.110***	0.032
	(3.92)	(3.68)	(1.28)
INTERCEPT	0.703***	0.662***	0.712***
	(28.53)	(18.95)	(17.50)
Year Fixed Effects	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes
N	11,516	5,698	5,818
Adj. R-squared	0.163	0.161	0.154

This table shows investor pricing on R&D capitalization. Panel A detects the value relevance of R&D capitalization and compare it between firms with high R&D quality and those with low R&D quality. Panel B provides the standardized coefficients for regressions in Panel A. *T*-statistics are reported in parentheses and calculated based on robust standard errors clustered at the firm level. All the variables are as defined in the Appendix. The superscripts *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively, in a two-tailed test in the regression.

Table 10
Real Effect of 2018 Disclosure Rule

VARIABLES	(1) *RDWORD*	(2) *RDLABOR*	(3) *RDINVEST*	(4) *RDWORD*	(5) *RDLABOR*	(6) *RDINVEST*
POST	0.063**	0.181***	0.085**	0.080***	0.219***	0.078**
	(2.11)	(3.92)	(2.23)	(2.58)	(4.60)	(2.02)
*POST*TREAT*				-0.034**	-0.076***	0.013
				(-1.99)	(-3.25)	(0.66)
EARNVAR	-3.596*	-0.558	2.011	-3.545*	-0.458	1.994
	(-1.94)	(-0.22)	(0.81)	(-1.92)	(-0.18)	(0.80)
EARNSIGN	0.041	-0.025	-0.020	0.040	-0.025	-0.020
	(1.49)	(-0.69)	(-0.67)	(1.48)	(-0.69)	(-0.66)
Size	0.150***	-0.003	0.117***	0.155***	0.007	0.116***
	(5.06)	(-0.07)	(3.16)	(5.23)	(0.18)	(3.12)
MB	-0.021***	-0.003	-0.032***	-0.022***	-0.004	-0.032***
	(-2.92)	(-0.29)	(-3.12)	(-2.98)	(-0.36)	(-3.11)
RD	1.756*	8.601***	18.557***	1.855*	8.846***	18.515***
	(1.76)	(5.56)	(15.90)	(1.86)	(5.71)	(15.88)
LEV	0.050**	0.011	0.028	0.051***	0.014	0.028
	(2.54)	(0.33)	(0.86)	(2.59)	(0.40)	(0.85)
BETA	-0.013	-0.042	-0.038*	-0.012	-0.039	-0.039*
	(-0.70)	(-1.52)	(-1.80)	(-0.63)	(-1.42)	(-1.83)
AGE	0.141	0.078	-0.008	0.145	0.083	-0.008
	(0.58)	(0.21)	(-0.02)	(0.60)	(0.22)	(-0.03)
RDGROWTH	0.028**	-0.031	0.050**	0.025*	-0.037	0.051**
	(2.10)	(-1.24)	(2.37)	(1.95)	(-1.45)	(2.41)
Constant	0.601	11.191***	9.515***	0.469	10.932***	9.558***
	(0.62)	(7.81)	(7.88)	(0.48)	(7.60)	(7.92)
Year Fixed Effects	No	No	No	No	No	No
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	4,232	4,326	4,326	4,232	4,326	4,326
Adj. R-squared	0.806	0.750	0.797	0.806	0.752	0.797

This table presents the real effect of regulation of R&D disclosure. We explore how R&D disclosure, R&D investment, and R&D quality changes around the 2018 rule change. *T*-statistics are reported in parentheses and calculated based on robust standard errors clustered at the firm level. All the variables are as defined in the Appendix. The superscripts *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively, in a two-tailed test in the regression.