R&D Accounting and Innovation Signaling: Insights from Japan's Pre-Regulation Era

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ABSTRACT

Following the adoption of SFAS 86 and IFRS, prior studies examined the shift from expensing to the mandatory capitalization of development costs. In contrast, we exploit pre-2000 Japan—when R&D activity thrived without formal accounting standards—as a natural experiment to analyze 1,916 inventing firms' R&D reporting choices, innovation outcomes, and the effects of a subsequent mandatory R&D expensing rule, mirroring the U.S. transition under SFAS 2. We find that firms generally follow the theoretical pecking order of financing, prioritizing debt over equity. To signal financial strength to creditors, inventing firms conservatively expense all R&D immediately, facilitating access to debt financing and enabling the scaling up of R&D activities. When financially constrained firms cannot expense all R&D or obtain debt, they selectively capitalize only high-quality projects to signal value to equity investors. The risk of future impairments provides equity investors with a mechanism to monitor project progress, encouraging ex ante support for risky but high-potential initiatives. The introduction of mandatory R&D expensing disrupted this equity-market-based signaling channel, making firms more reliant on debt and less focused on project quality. These findings offer the Financial Accounting Standards Board (FASB) counterfactual insights not observable in the U.S. market after adopting SFAS 2 in 1975.

Keywords: R&D capitalization, R&D expensing, SFAS No. 2, patent, financing for innovation, signaling, Japan, accounting standard

JEL Classification: O30, M41

1. Introduction

Studies focused on U.S. firms under SFAS No. 2—which mandates immediate R&D expensing—cannot assess whether accounting treatment (capitalization versus expensing) leads to differential innovation outcomes. Following IFRS adoption, several studies have examined the shift from expensing to mandatory capitalization in the U.K. and Germany (Oswald, Simpson, and Zarowin 2022; Oswald, Ryu, and Zarowin 2023; Ryu and Zarowin 2024; Bhattacharya, Saito, Venkataraman, and Yu 2024). Aboody and Lev (1998) similarly study 163 U.S. software firms around the adoption of SFAS 86. These studies find that mandated capitalization increases R&D spending, sales, earnings response coefficients, and stock returns.

However, no accounting studies have directly examined whether R&D accounting treatment—capitalization versus expensing—leads to differential innovation outcomes, and little is known about the reverse transition—from discretionary capitalization to mandatory expensing—as under SFAS 2. Based on a small sample of 99 firms, Wasley and Linsmeier (1992) find no significant market reaction to the SFAS 2 announcement.

Our study fills this gap by examining the R&D reporting choices and patent-based innovation outcomes of 1,916 publicly listed Japanese inventing firms around the 1997 announcement and 2000 implementation of a mandatory R&D expensing rule. This regulatory shift, mirroring the earlier U.S. experience under SFAS 2, provides a unique setting to analyze reporting behavior in the absence of formal standards and the effects of mandatory expensing on firms' innovation strategies.

Building on the pecking order of financing framework (Myers and Majluf 1984), we hypothesize that inventing firms seeking external financing prioritize debt—partly due to associated tax benefits—before turning to public equity markets. Because creditors are primarily concerned with downside risk (Merton 1974; Myers 1977; Shi 2003), inventing firms adopt a conservative approach by immediately expensing all R&D as a signal of firm-level financial strength. Access to debt financing, in turn, allows these firms to scale up R&D activities, as reflected in increased patent applications and broader patent family coverage.

However, financially constrained firms unable to expense all R&D or secure debt financing must rely on equity markets. Given the long time horizons, knowledge-intensive nature, and inherent uncertainty of R&D activities (Arrow 1962; Hall and Lerner 2010), communicating private information about high project quality poses significant challenges. Following Spence's (1973) signaling framework, we posit that such firms selectively capitalize only high-quality R&D projects—such as those associated with high forward citation counts or greater technological generality—to signal superior project quality to equity investors. For the signal to be credible, it must entail a cost; otherwise, firms would capitalize all R&D projects, and the signal would lose its informativeness.

A key cost associated with capitalization is the heightened scrutiny over R&D asset impairments. Investors may question the balance sheet carrying value of capitalized R&D and demand regular updates on project progress. If impairments are subsequently recognized, market participants may revise firm valuations downward, leading to reduced access to external equity financing or higher costs of capital. This ex post penalty reinforces the credibility of ex ante R&D capitalization as a signal of project quality. In this context, financial reporting choices provide investors with a relatively low-cost screening mechanism, reducing their reliance on interpreting complex and technical patent disclosures. Indeed, Zheng (2025) finds that equity markets often respond incompletely to information contained in public patent filings, highlighting the value of concise, accessible signals provided through financial statements—signals that can inform investors without revealing proprietary innovation details to potential competitors (Bhattacharya and Ritter 1983).

The introduction of a mandatory R&D expensing rule eliminated this signaling channel. Financially constrained firms, required to expense all R&D, lost incentives to prioritize project quality, while equity investors could no longer distinguish high-quality projects based on voluntary capitalization decisions. Simultaneously, creditors lost the ability to use voluntary expensing decisions as signals of firm-level financial strength. Consistent with Hayek's (1945) view that decentralized private information is critical for market efficiency, the mandated R&D expensing rule ultimately restricted inventing firms from communicating private information about both firm-level financial strength and project-level quality to public capital markets.

Results from our empirical analysis support these conjectures. During the pre-regulation period from 1990 to 1996, approximately 11 percent of Japanese inventing firms capitalized at least a portion of their R&D expenditures, while the remaining 89 percent expensed all R&D immediately. This relatively low capitalization rate is consistent with the existence of high signaling costs, as described by Spence (1973). Among capitalizing firms, 96 percent adopted a five-year useful life for R&D assets; however, annual impairment rates averaged approximately 28 percent, implying an effective useful life of about 3.6 years. The average impairment amount was ¥747 million Japanese yen, equivalent to approximately $6.4 million USD in 1990s terms.

To examine the association between the amount of R&D costs capitalized versus expensed and patent quality outcomes during the pre-regulation period, we employ a Poisson regression model with year and industry or year and firm fixed effects (Cohn, Liu, and Wardlaw 2022). Control variables include firm size, market-to-book ratio, leverage, and sales growth to account for systematic differences between capitalizing and expensing firms. Project quality is proxied by the number of forward citations over the subsequent ten years, normalized by the number of patents granted in the year corresponding to R&D reporting choices. We find that capitalized R&D is positively and significantly associated with forward citations per patent, whereas expensed R&D is not. Using an alternative proxy—the average number of technological classes per granted patent, reflecting technological generality—we find similar results: a significant positive association with capitalized R&D and a moderately negative association with expensed R&D.

Further analysis shows that the results based on technological class breadth are primarily driven by loss-making and highly leveraged firms, those facing financial constraints, while the citation-based findings remain robust across different profitability and leverage levels. These results reinforce the project-level high-quality signaling hypothesis.

To address concerns regarding a potential denominator effect in the patent quality measure, we also examine the relationship between R&D reporting choices and the volume of patent grants. We find no significant association, suggesting that the quality-based results are not mechanically driven by variation in patent quantity. However, expensed R&D is positively associated with the number of patent applications and the breadth of patent families, while capitalized R&D shows no such relationship. This pattern suggests that firms expensing R&D are more likely to pursue broader patenting strategies across multiple jurisdictions, despite no observable differences in project quality. These volume effects are most pronounced among profitable firms, consistent with the firm-level financial strength signaling hypothesis.

To assess the effects of the regulatory transition, we conduct a difference-in-differences analysis using a Poisson fixed effects model with entropy balancing weights. Treatment firms are defined as those that voluntarily capitalized R&D pre-regulation but were required to expense all R&D post-regulation, while control firms consistently expensed all R&D before and after the mandate. We observe a moderate decline in patent quality and a significant increase in patenting volume among treatment firms following the regulation. These effects are particularly pronounced among loss-making and highly leveraged firms. The findings suggest that once the ability to signal project quality through capitalization was eliminated, firms shifted toward increasing patent application volume—likely facilitated by improved access to external debt financing under a pooling equilibrium—but with diminished incentives to prioritize innovation quality.

Finally, we examine the differential responses of equity and debt markets to R&D accounting practices across the two reporting regimes. Consistent with Aboody and Lev (1998), we find that capitalized R&D is positively associated with annual stock returns during the pre-regulation period, indicating that equity investors interpreted capitalization as a credible signal of high project quality. In contrast, expensed R&D is not significantly associated with stock returns under either regime. Conversely, expensed R&D is positively associated with the volume of debt financing, though not with the cost of debt, suggesting that creditors viewed expensing as a signal of firm-level financial strength. This interpretation aligns with our earlier finding linking expensing to higher patenting volume and is consistent with Shi (2003), who argues that creditors are more sensitive than equity investors to uncertainty surrounding R&D projects.

These findings offer the Financial Accounting Standards Board (FASB) a set of counterfactual insights not observable in the U.S. market following the adoption of SFAS 2 in 1975. Nonetheless, important contextual differences between the Japanese and U.S. innovation ecosystems must be considered when interpreting the generalizability of our results. First, the Japanese sample comprises established, publicly listed firms, whereas many inventing firms in the U.S. are young and privately held. Second, unlike the U.S., where a vibrant venture capital market plays a central role in innovation funding, Japanese inventing firms primarily depend on bank loans and the public bond or equity market. Third, Japanese firms are more likely to use patents as a means of protecting intellectual property, whereas U.S. firms often rely on secrecy.

Our study also addresses long-standing gaps in the accounting, finance, and innovation literatures. Within the U.S. expensing-only regime, accounting studies have focused on the relationship between R&D expenditures and financial performance (e.g., Shevlin 1991; Sougiannis 1994; Lev and Sougiannis 1996; Donelson and Resutek 2012; Curtis, McVay, and Toynbee 2020; Resutek 2022; Baber, Kang, Lee, and Park 2023; Campbell, Chen, Guan, and Ye 2023; Iqbal, Rajgopal, Srivastava, and Zhao 2025; Glaeser, Lang, Omartian, and Pae 2025), while finance and innovation studies have examined the link between R&D and patenting (see Chuang, Hsu, Kuan, and Yang 2025, Table 1, for a review of work published in leading economics, finance, law, and management journals between 2011 and 2020). However, these studies typically rely on single-regime data, limiting their ability to isolate the effects of accounting treatment on innovation outcomes.

From the foundational work of Schumpeter (1942) and Solow (1957) to more recent contributions by Bloom, Jones, Van Reenen, and Webb (2020) and Park, Leahey, and Funk (2023), it is well established that innovation plays a central role in driving economic growth. However, relatively little is known about whether financial reporting choices—particularly those related to expensing versus capitalizing R&D—affect the quality of innovation activities. Our study is the first to examine, in a large-sample setting, the innovation-related—rather than purely financial—implications of a regulatory shift from voluntary capitalization to mandatory expensing. We find that this change elicited distinct responses from equity and debt markets and provide evidence that R&D reporting choices meaningfully influence innovation outcomes, particularly with respect to project quality and patenting volume.

The remainder of the paper is structured as follows. Section 2 reviews the relevant R&D accounting literature, elaborates on the Japanese institutional context, and introduces the signaling hypotheses. Section 3 describes the data sources and presents key summary statistics. Section 4 details the empirical models and findings, while Section 5 concludes by discussing the broader implications of our results and potential avenues for future research.

2. Related Literature and Theoretical Framework

2.1 R&D ACCOUNTING AROUND THE WORLD

Innovation has played a central role in the post–World War II economic expansion of the United States, with R&D expenditures rising from $38 billion (1.3% of GDP) in 1953 to an estimated $716 billion (3.4% of GDP) in 2021 (see Figure 1). In October 1974, the Financial Accounting Standards Board (FASB) issued SFAS No. 2, *Accounting for Research and Development Costs*, which mandated the immediate expensing of R&D costs due to the inherent uncertainty surrounding the future economic benefits of innovative activities. Wasley and Linsmeier (1992) conducted an event study around key SFAS 2 announcement dates and found no significant equity market reaction, except for a modest negative response among a subset of over-the-counter (OTC) firms.

Subsequently, in August 1985, the FASB issued SFAS No. 86, which permitted the capitalization of development costs for internally generated software once technological feasibility had been established—defined as the completion of a detailed program design or a working prototype. Aboody and Lev (1998) analyzed 163 software firms (SIC codes 7370–7372) over the period 1987–1995 and documented a positive association between capitalized development costs and stock returns, whereas expensed research costs exhibited no such relationship. Their findings also indicate that smaller and less profitable firms were more likely to capitalize development costs, consistent with the view that the assessment of technological feasibility involves managerial discretion. Importantly, capitalized development costs were found to be more strongly associated with future earnings growth than expensed R&D.

Further supporting this perspective, Mohd (2005) finds that software firms transitioning from mandatory expensing to mandatory capitalization under SFAS 86 experienced narrower bid–ask spreads and higher share turnover, consistent with improvements in the information environment following capitalization. Despite periodic discussions, U.S. GAAP has seen little substantive change in R&D accounting practices since the issuance of SFAS 86. For instance, the Financial Accounting Standards Board (FASB) recently issued an Invitation to Comment as part of its Recognition of Intangibles project, indicating that substantive revisions to the broader R&D reporting framework have yet to materialize (FASB, 2025).

Internationally, researchers have examined the implications of the International Financial Reporting Standards (IFRS) in non-U.S. contexts to explore counterfactual scenarios where alternative R&D accounting approaches might yield different financial outcomes. IFRS's International Accounting Standards No. 38 requires the immediate expensing of research costs on the income statement, while allowing the capitalization of development costs on the balance sheet, similar to FASB's SFAS No. 86, but with a broader scope beyond software. The criteria for capitalization include technical feasibility, probable future economic benefits, reliable measurement of costs, and the ability and willingness to complete projects.

Before the adoption of IFRS, U.K. Generally Accepted Accounting Principles (GAAP) allowed firms to choose between expensing and capitalizing development costs. Oswald and Zarowin (2007) find that firms choosing to capitalize development costs exhibit higher future earnings response coefficients (ERCs) compared to those that expensed development costs, suggesting that capitalization may enhance the informativeness of earnings. In contrast, Oswald (2008) finds no significant difference in the return–R&D association between capitalizing and expensing firms, indicating that the market's valuation of development costs may not differ meaningfully across reporting choices.

Following the adoption of IFRS, companies that previously expensed development costs (referred to as "switchers") were required to capitalize them. Research by Oswald, Simpson, and Zarowin (2022) indicates that these switchers increased R&D expenditures and were less likely to cut R&D spending to meet analysts' earnings expectations (Oswald, Ryu, and Zarowin 2023). Moreover, the equity market did not differentiate between the mandated expensing of research costs and the voluntary expensing of development costs prior to the IFRS regime (Ryu and Zarowin 2024). Overall, evidence from the U.K. context suggests that the selective capitalization mandate provides relevant information to investors, allowing capitalized development costs to furnish additional resources for firms to pursue further projects. However, the reasons some firms chose to voluntarily expense development costs under the pre-IFRS regime remain unclear.

In Germany, R&D expenditures rose from 1.7% of GDP in 1991 to 4.6% in 2021 (see Figure 2). Bhattacharya, Saito, Venkataraman, and Yu (2024) examine the transition from mandatory expensing under German GAAP to mandatory capitalization of development costs following the adoption of IFRS. They find that this shift is associated with increased sales revenue per unit of input—measured using indicators such as property, plant, and equipment (PP&E), cost of goods sold (COGS), SG&A, and R&D—suggesting that mandatory expensing may have limited firms' capacity to realize productivity gains later observed under the IFRS regime. These findings align with evidence from the U.S. software industry, where the transition under SFAS 86 from mandatory expensing to mandatory capitalization led to improved market valuations and reductions in information asymmetry (Aboody and Lev 1998; Mohd 2005).

In South Korea, R&D expenditures similarly surged from 1.7% of GDP in 1991 to 4.9% in 2021 (see Figure 2). The Korean GAAP for R&D accounting aligns with IFRS's IAS 38 requirements, mandating the expensing of research costs and capitalizing development costs as assets. Research by Baber, Kang, Lee, and Park (2023) confirms a uniform R&D accounting regime in Korea, demonstrating that firms typically rely on internal cash flows for research funding and external financing, such as secondary equity issuances, to support development costs.

Although still trailing OECD countries, China has experienced significant growth in R&D investment, with expenditures rising from 0.7% of GDP in 1991 to 2.4% in 2021. Campbell, Chen, Guan, and Ye (2023) examine the relationship between the average wage of R&D personnel and the quality of firms' R&D output. Their findings suggest that higher average R&D wages are associated with a lower likelihood of firms cutting R&D expenditures—consistent with the cost stickiness argument advanced by Anderson, Banker, and Janakiraman (2003)—as well as with higher patenting activity per employee and a greater propensity to capitalize R&D costs on the balance sheet rather than expense them through the income statement. Their analysis begins in 2015, when wage disclosure data became available, and reflects China's unified R&D accounting framework following its adoption of IFRS in 2006.

Complementing this evidence, Glaeser, Lang, Omartian, and Pae (2025) analyze detailed R&D expenditure components using U.S. Census data and confirm that compensation constitutes more than half of total R&D spending—the largest cost category, as also noted by Hall and Lerner (2010). Despite the prominence of labor costs, their findings indicate that equity markets do not fully incorporate this detailed R&D cost information into firm valuations.

In conclusion, the existing accounting literature on R&D reporting has primarily focused on its relationship with financial performance and stock returns. By examining patent-based innovation outcomes, our study complements this body of work and addresses an important gap in the literature concerning the productivity mechanisms underlying R&D investments. Moreover, prior research leveraging cross-regime settings to identify the effects of accounting choices has largely centered on transitions from voluntary or mandatory expensing (e.g., under U.K. GAAP, SFAS 2, or German GAAP) to mandatory capitalization (e.g., under SFAS 86 or IFRS). In contrast, relatively little is known about policy shifts in the opposite direction—namely, from voluntary capitalization to mandatory expensing—as occurred with the adoption of SFAS 2.

The limited event study by Wasley and Linsmeier (1992), which examined investor reactions around the announcement of SFAS 2, offers only narrow insight into market expectations due to its small sample and short event window. In contrast, our study provides large-sample evidence spanning an extended pre- and post-regulatory period, allowing us to investigate the broader and longer-term implications of transitioning from an unregulated environment to one mandating immediate R&D expensing. In doing so, we offer novel insights into counterfactual scenarios that remain obscured within the U.S. context following the implementation of SFAS 2.

2.2 JAPAN R&D ACCOUNTING AND INSTITUTIONAL BACKGROUND

From 1968 until 2010, Japan held the position of the world's second-largest economy by GDP, before being surpassed by China. At the beginning of our sample period in 1991, both Japan and the United States allocated 2.6% of their GDP to R&D expenditures, positioning them as global leaders in innovation (see Figure 2). In both countries, private-sector firms played a central role in driving R&D investment, emphasizing the importance of understanding how financial reporting practices influence the financing of firm-level innovation.

A 1994 survey by Cohen, Goto, Nagata, Nelson, and Walsh (2002) of Japanese and American manufacturers provided further comparative insights. Focusing on firms with annual revenues exceeding US$50 million, the survey revealed that U.S. firms (826 in total) tended to be larger, often operating as multi-business units, compared to their Japanese counterparts (593 firms). However, Japanese firms exhibited higher R&D intensity, spending a larger proportion of revenue on R&D activities than comparable U.S. firms. This difference in R&D intensity stems largely from Japan's relatively greater focus on less R&D-intensive industries, as the two countries share similar R&D intensity in sectors such as pharmaceuticals and semiconductors (Brown, Fazzari, and Petersen 2009). Additionally, Japanese firms were found to rely more heavily on patents to protect their innovations, while U.S. firms favored secrecy as a primary mechanism for safeguarding intellectual property.

Despite the robust R&D activities, Japan did not implement a formal R&D accounting standard until 1998. During the pre-regulation period, firms had the discretion to either expense R&D costs under Selling, General, and Administrative (SG&A) expenses or Cost of Goods Sold (COGS) on the income statement or capitalize them as long-term intangible assets on the balance sheet, subject to amortization schedules or impairment assessments. This pre-regulation period offers a natural experiment to examine how firms exercised accounting discretion and its relationship with their innovation strategies.

The 1997 June announcement and the 1998 issuance of Japanese GAAP related to R&D costs, developed by the Business Accounting Council (BAC), established explicit guidelines for the accounting treatment of R&D expenditures. The primary requirement stipulated that firms must expense R&D costs as incurred, closely mirroring the provisions of U.S. GAAP's SFAS 2, which also mandates immediate expensing of R&D. Although the standard did not officially take effect until March 2000, many firms began adopting the expensing method following the 1998 announcement. It is worth noting that nearly 70% of Japanese listed firms have a fiscal year ending in March. As a result, for the purpose of this study, the pre-regulation period is defined as the fiscal years from 1990 to 1996, during which no formal R&D accounting standards were in place.

The post-regulation period, when the standards were fully implemented, spans from 2001 to 2007. In 2009, the Financial Services Agency of Japan began allowing some publicly listed firms to voluntarily adopt IFRS, creating a dual-accounting regime. To avoid the comingling of Japanese GAAP and IFRS in the analysis, the sample period ends in 2007. The 1997 to 2000 period is treated as a transitional phase as firms adjusted to the upcoming regulatory requirement.

2.3 SIGNALING HYPOTHESES

Innovation quality is largely private to the inventing firm and varies considerably across projects. Glaeser, Lang, Omartian, and Pae (2025) report that over 80 percent of the variation in R&D spending is attributable to firm-specific factors, while observable characteristics—such as location, industry, and macroeconomic conditions—explain less than 10 percent. Consistent with this idiosyncratic nature, Nallareddy and Ogneva (2022) find that R&D reporting choices have negligible effects on macroeconomic aggregates, underscoring the limited visibility of innovation quality to external capital providers. The long time horizons, knowledge-intensive nature, and inherent uncertainty of R&D projects create challenges for firms seeking to credibly convey private information about project quality (Arrow 1962; Hall and Lerner 2010; Kerr and Nanda 2015). Investors, in turn, face substantial ambiguity regarding the likelihood that R&D investments will ultimately generate returns.

Building on Spence's (1973) signaling framework, we hypothesize that capitalizing R&D serves as a credible signal of high project quality, while expensing is more likely for lower-quality projects. For capitalization to function as a credible signal, it must impose a cost; otherwise, all firms would capitalize R&D, eliminating the signal's informativeness. A key cost arises from the heightened scrutiny linked to the risk of future impairments of capitalized assets. Investors may question the balance sheet value of these assets and require regular updates on project progress.

Verifiability is supported by the role of external auditors, who apply standardized criteria to assess whether an R&D project meets the definition of a long-term asset—namely, one expected to generate economic benefits for more than one year or the firm's operating cycle, whichever is longer. Credibility is further reinforced by the requirement to write down the asset's value if the project fails. Impairments, as documented in Japanese case studies (see Appendix A), often lead to negative investor reactions, reducing a firm's access to external capital or increasing its cost of financing. These ex post penalties enhance the credibility of ex ante capitalization decisions.

In this context, R&D reporting choice becomes a low-cost screening mechanism that helps investors infer project quality, mitigating the reliance on complex and often underutilized patent disclosures. Supporting this view, Zheng (2025) finds that equity markets frequently respond only partially to information embedded in public patent filings.

Hypothesis 1: R&D projects that are capitalized on the balance sheet are more likely to result in higher-quality innovation outcomes.

An alternative signaling mechanism may operate through R&D expensing, particularly as a reflection of firm-level financial strength. Immediate expensing reduces reported earnings, thereby imposing a cost that financially constrained firms may be unwilling or unable to bear. This costliness can deter imitation, making expensing a credible signal of financial robustness. In Japan, where financial statements play a central role in bank lending decisions, consecutive operating losses may disqualify firms from obtaining loans. Interviews with bankers at a large Japanese conglomerate indicate that shifting from capitalization to expensing negatively affects key financial ratios—such as return on assets and return on equity—thereby diminishing a borrower's perceived creditworthiness and limiting access to external financing.

As a result, firms with sufficient financial strength may choose to expense all R&D immediately as a credible signal directed primarily at creditors, who tend to be more concerned about the uncertainty of R&D investments than equity holders and favor more conservative reporting practices (Shi 2003; Beaver and Ryan 2005).

Hypothesis 2: Firms that immediately expense R&D expenditures in the income statement tend to exhibit stronger financial positions.

Importantly, signaling through capitalization and expensing may coexist, as they address distinct types of information asymmetries—project-level and firm-level, respectively—and may be targeted toward different capital providers, such as equity and debt investors. This dual signaling equilibrium is plausible in institutional environments where firms retain discretion over R&D reporting choices.

3. Data and Sample

3.1 SAMPLE DESCRIPTION

Our sample includes 15,977 firm-year observations from 1,916 publicly traded Japanese R&D-reporting companies, sourced from the Development Bank of Japan database, spanning the periods 1990–1996 (pre-regulation) and 2001–2007 (post-regulation). We use unconsolidated financial data because patent data is identified at the individual entity level, and public firms in Japan primarily disclosed unconsolidated financial statements until 2000. Table 1, Panel A outlines the accounting treatments applied when R&D costs were incurred. Expensing all R&D costs as incurred, consistent with U.S. GAAP (SFAS 2), contrasts with two other practices central to our study: 'capitalizing all R&D costs' and 'both expensing and capitalizing R&D costs,' both of which are prohibited under U.S. GAAP (except for software development costs).

Firms employing these two alternative accounting practices form our treatment group, while firms exclusively expensing all R&D costs serve as the benchmark group. Notably, during the pre-regulation period, the treatment group represented 11 percent of listed R&D firms, but post-regulation, only the immediate expensing of R&D costs is allowed. The relatively small proportion of firms in the treatment group is consistent with the high ex-ante signaling costs in a separating equilibrium, as outlined in Spence's (1973) signaling theory. Such costs deter firms lacking high-quality R&D projects from mimicking the signal—i.e., capitalizing R&D expenditures—thereby preserving the informativeness of the signal for market participants.

For the pre- and post-regulation analysis, we construct a constant firm sample, as shown in Table 1, Panel B, to ensure that our results are not influenced by variations in firm types across accounting regimes. Using 1996 as the base year, we find that 84 percent of firms that capitalized R&D costs at least once during the pre-regulation period were still listed in 2007. This survivorship rate is comparable to that of firms that never capitalized R&D over the same period, helping to mitigate concerns about differential survivorship rates as a confounding factor in our analysis. To further address intertemporal differences, we include year fixed effects in our regression models.

Consistent with the findings from Cohen, Goto, Nagata, Nelson, and Walsh (2002), R&D activities are widespread across industries. As shown in Table 1, Panel C, the top three R&D-intensive industries are electrical equipment, machinery, and chemicals. Interestingly, less typical R&D sectors such as construction, food, and textiles rank among the next most R&D-intensive industries. Additionally, more than half of the R&D firms in our sample have filed at least one patent application, reflecting the higher reliance of Japanese firms on patents compared to U.S.

firms (Cohen et al., 2002), except in software (under 'Other Services'), where patent protection is often limited.

Industry distributions remain consistent across the pre- and post-regulation periods, as well as between the full and constant firm samples, ensuring comparability across accounting regimes. The propensity to capitalize R&D costs on the balance sheet is also proportionate across industries, with the exception of construction firms, which show a slightly lower tendency to capitalize. To account for these industry-specific differences, we include more granular industry fixed effects in our regression analysis.

3.2 VARIABLE DESCRIPTION

Table 2 displays the distributions of the variables used in our analysis, while Appendix B provides detailed definitions for each variable. Panel A presents the pre-regulation sample, and Panel B offers a comparison using the post-regulation constant firm sample. During the pre-regulation period, the average and median firm sizes in the sample were ¥143 billion and ¥41 billion, respectively—approximately equivalent to $1.2 billion and $243 million in 1990s U.S. dollars. Treatment firms—defined as those that capitalize some or all R&D expenditures—have an average size of ¥72 billion, which is notably smaller than the ¥155 billion average size of benchmark firms—defined as those that expense all R&D expenditures. Moreover, treatment firms tend to have higher market-to-book ratios, greater leverage, and are generally older than benchmark firms. While sales growth rates are similar across both groups, benchmark firms demonstrate higher profitability, as indicated by return on assets and a lower incidence of losses. Both groups exhibit comparable R&D intensity, although treatment firms are less likely to be audited by large international CPA firms and tend to hold lower cash balances. In the post-regulation period, similar patterns persist, except that treatment firms show stronger sales growth and no longer lag behind benchmark firms in terms of return on assets.

Table 2 also reports the distributions of patent-related variables. The treatment group exhibits a significantly lower average number of 10-year forward citations per granted patent, while the average number of technological classes per patent is statistically indistinguishable between the two groups. Measures of patent volume—including the number of grants, applications, and patent families—are all significantly higher for the benchmark group, likely reflecting their larger firm size.

4. Empirical Models and Results

4.1 FIRM-LEVEL SIGNALING HYPOTHESES IN THE PRE-REGULATION ERA

We begin by testing Hypothesis 2, which posits that the decision to expense all R&D on the income statement is positively associated with firm-level financial strength. Given the binary nature of the dependent variable, we employ a logistic regression model, focusing on the pre-regulation period from 1990 to 1996:

$$I[\text{Capitalizing R\&D}]_{i,t} = \sum \beta_j \,\text{Firm\_characteristics}_{j,i} + \sum y_t \,\text{Year}_t + \sum d_n \,\text{Industry}_n + \varepsilon_{i,t} \qquad (1)$$

The variable *I[Capitalizing R&D]* is a binary indicator, equal to one for the 982 treatment firms and zero for the 6,014 control firms in the 1990–1996 period, as shown in Table 1, Panel B. The constant firm sample, presented in Table 1, Panel B, includes firms that are present in both the pre- and post-regulation periods. We analyzed nine firm characteristics. To account for temporal and industry-specific differences, we included year and industry fixed effects in the regression. Standard errors are clustered at the firm level, as the unit of observation is each firm.

Smaller firms with higher leverage and lower profitability are more likely to voluntarily capitalize R&D costs on the balance sheet rather than expense them on the income statement.

These findings are consistent with Aboody and Lev (1998), who studied U.S. software companies from 1987 to 1995, and Oswald, Simpson, and Zarowin (2022), who analyzed U.K. listed firms from 2001 to 2012. Unlike the U.K. sample, however, Japanese firms that capitalize R&D costs are similar in age to those that expense R&D, with an average of 51 years since incorporation. Overall, the distinct characteristics between the treatment and benchmark firms align with our firm-level financial strength signaling hypothesis.

4.2 PROJECT QUALITY DIFFERENCES: CAPITALIZED VS. EXPENSED R&D

In addition to testing the firm-level signaling hypothesis, we further examine Hypothesis 1—the decision to capitalize R&D on the balance sheet is positively associated with the high quality of R&D projects. Specifically, we analyze the relationship between the amount of R&D costs capitalized versus expensed and patent quality outcomes. To do so, we estimate the following Poisson regression model—given the count nature of the dependent variable (Cohn, Liu, and Wardlaw 2022)—focusing on the pre-regulation period from 1990 to 1996:

$$\text{Patent\_Quality}_{i,t} = \sigma\Delta\text{Expensed\_RD}_{i,t} + \gamma\Delta\text{Capitalized\_RD}_{i,t} + \sum\beta_j\text{Firm\_characteristics}_{j,i,t-1} + \rho\text{Patent\_Quality}_{i,t-1} + \sum y_t\text{Year}_t + \sum d_n\text{Industry/Firm}_n + \varepsilon_{i,t} \quad (2)$$

Including serially correlated variables in a regression model can lead to inflated coefficients without adding explanatory power (see Granger and Newbold, 1974). Given the strong serial correlation of R&D costs with their first lag, we use the change variable instead of the level variable. For example, ΔExpensed_RD represents the change in R&D expenses reported on the income statement from fiscal year t-1 to year t, scaled by the book value of total assets at the beginning of the year. The first-order serial correlations for Expensed_RD (level) and ΔExpensed_RD (change) are 0.96 and 0.07, respectively, demonstrating that applying an AR(1) adjustment effectively eliminates significant autocorrelation. Similarly, ΔCapitalized_RD represents the change in capitalized R&D added to the balance sheet from fiscal year t-1 to year t, also scaled by the book value of total assets at the beginning of the year. The first-order serial correlations for Capitalized_RD (level) and ΔCapitalized_RD (change) are 0.72 and -0.16, respectively, further confirming that the AR(1) adjustment successfully removes material autocorrelation.

Patent_Quality refers to either Avg. Citations per Granted Patent or Avg. Classes per Granted Patent (Hall, Jaffe, and Trajtenberg 2001). Avg. Citations per Granted Patent measures the average number of forward citations received over a ten-year window, beginning with the fiscal year in which the change in R&D expenditures (either expensed or capitalized) is recorded. The calculation is based on patents granted by the Japanese Patent Office in that same fiscal year. A higher citation count is generally interpreted as indicative of greater technological impact and project quality. Avg. Classes per Granted Patent captures the average number of technological classification codes listed in patent applications for patents granted in the fiscal year corresponding to the change in R&D expenditures. These classification codes are analogous to industry groupings; a greater number of classes suggests broader technological generality and potential applicability across fields.

To maintain consistency with the change-variable framework, we include the lagged value of the dependent variable (Patent_Quality$_{i,t-1}$), corresponding to the year prior to when R&D costs are incurred. However, as the inclusion of lagged dependent variables can introduce bias in Poisson regression models, we also estimate the specification without the lag for comparison. Year and industry/firm fixed effects are included in the regression. When the dependent variable is equal to zero for all observations within a given industry or firm fixed effect, that group is automatically dropped from the Poisson regression estimation (Cohn, Liu, and Wardlaw 2022), resulting in variation in the number of observations across model specifications. Further, we cluster standard errors at the firm level to account for correlated firm activities over time.

In Table 4, we find that capitalized R&D projects are positively associated with higher patent quality, as measured by both forward citations and technological generality. Specifically, an average value of ΔCapitalized_RD is associated with a 0.14% increase in the number of forward citations received within ten years of the patent grant, and a 0.10% increase in the number of technological classification codes per granted patent. In contrast, expensed R&D exhibits a weak and negative association with technological generality. These results support our hypothesis (H1) that capitalized R&D reflects higher project quality. To our knowledge, this is the first study to empirically document the distinct patent outcome characteristics associated with capitalized versus expensed R&D under alternative accounting treatments.

When we partition the sample into profitable and loss-making firms, we find that the positive association between capitalized R&D and patent citations is concentrated among profitable firms, whereas the positive association with technological generality is concentrated among loss-making firms. When we instead partition the sample based on the annual median leverage level, we observe that both low- and high-leverage firms contribute to the positive patent citation results, but the positive association with technological generality is concentrated among highly leveraged firms. Overall, these findings suggest that the positive relationship between capitalized R&D and technological generality is driven primarily by financially constrained firms—those reporting losses or exhibiting higher leverage. In contrast, the positive relationship between capitalized R&D and patent citations is not limited to financially constrained firms. These results suggest that the project-level high-quality signaling hypothesis is distinct from the firm-level financial strength hypothesis.

4.3 PROJECT VOLUME DIFFERENCES: CAPITALIZED VS. EXPENSED R&D

To address concerns about a potential denominator effect in the patent quality measure, we also analyze patent volume using a comparable Poisson fixed effects regression model.

$$\text{Patent\_Volume}_{i,t} = \sigma\Delta\text{Expensed\_RD}_{i,t} + \gamma\Delta\text{Capitalized\_RD}_{i,t} + \sum\beta_j\text{Firm\_characteristics}_{j,i,t-1} + \sum y_t\text{Year}_t + \sum d_n\text{Industry/Firm}_n + \varepsilon_{i,t} \quad (3)$$

Specifically, we replace Patent_Quality in Equation (2) with Patent_Volume, measured as the number of patent grants, applications, or families. As reported in Table 5, we do not find a significant difference in the number of awarded patents between expensed and capitalized R&D projects, suggesting that the citation differences observed in Table 4 are driven by citation intensity rather than by differences in the volume of patents. However, we find a significant positive association between expensed R&D and both patent application volume and family coverage, potentially reflecting greater access to debt financing among firms that signal financial strength by immediately expensing all R&D costs. Notably, the fact that these patent volume results are driven exclusively by profitable firms reinforces the firm-level financial strength hypothesis.

Overall, our findings reveal a positive association between capitalized R&D and patent quality, and a positive relationship between expensed R&D and patent volume, underscoring the interdependence between financial R&D reporting choices and firms' innovation activities. The absence of prescriptive regulation during this period allows us to observe firms' endogenous bundling of financial reporting strategies with their innovation decisions.

4.4 DIFFERENCE-IN-DIFFERENCE COMPARISON

Next, we examine the rare transition from voluntary capitalization to mandatory expensing in a difference-in-difference design to evaluate how firms adjust their innovation strategies following the removal of a project-quality signaling mechanism in Japan after 2000. The adoption of U.S. GAAP-like R&D expensing regulations in 2000 eliminated the option to capitalize R&D

costs on the balance sheet. To ensure comparability across accounting regimes, we pool capitalized and expensed R&D from the pre-regulation period as total R&D, aligning it with the post-regulation phase. The difference-in-difference Poisson regression model below explores the relationship between changes in total R&D and patent outcomes.

$$\text{Patent\_Variable}_{i,t} = \omega_1 \Delta\text{Total\_RD}_{i,t} \times \text{POST}_{i,t} \times \text{TREAT}_{i,t} + \omega_2 \Delta\text{Total\_RD}_{i,t} \times \text{POST}_{i,t} + \omega_3 \Delta\text{Total\_RD}_{i,t} \times \text{TREAT}_{i,t} + \omega_4 \Delta\text{Total\_RD}_{i,t} + \omega_5 \text{POST}_{i,t} \times \text{TREAT}_{i,t} + \omega_6 \text{TREAT}_{i,t} + \sum \beta_j \text{Firm\_characteristics}_{j,i,t-1} + \sum y_t \text{Year}_t + \sum d_n \text{Industry/Firm}_n + \varepsilon_{i,t} \quad (4)$$

ΔTotal_RD captures the change in total R&D costs, including both expensed and capitalized amounts. POST denotes the post-regulation period, while TREATment equals one for firms that capitalized R&D costs at least once during the pre-regulation period, as outlined in Table 1, Panel B (the constant firm sample), and zero for firms that expensed all R&D costs before and after the regulation. The difference-in-difference design includes six variables based on the interactions or individual effects of these three factors. The standalone effect of POST is absorbed by the year fixed effects. We further apply entropy balancing weights to enhance comparability between the treatment and control firms. The covariates used in the entropy balancing procedure include Firm Size, Market-to-Book ratio, Leverage, Firm Age, Sales Growth, Return on Assets, Loss Indicator, Big N Auditor, and R&D Intensity, with balancing performed on the first three moments (mean, variance, and skewness) of each variable.

Our primary focus is on the triple interaction term, $\Delta\text{Total\_RD}_{i,t} \times \text{POST}_{i,t} \times \text{TREAT}_{i,t}$, which captures the change in the relationship between R&D input and patent output for pre-regulation capitalizing firms compared to expensing firms during the post-regulation period. This design is more robust than using the double interaction term, $\text{POST}_{i,t} \times \text{TREAT}_{i,t}$, because the triple interaction further isolates the covariance between R&D input and patent output. While noninnovation confounding factors—such as the R&D tax credit in 2003 (Kasahara, Shimotsu, and Suzuki, 2014)—could potentially be captured by the double interaction term, $POST_{i,t} \times TREAT_{i,t}$, they are unlikely to explain the specific patterns identified by the triple interaction. The rest of the model follows the structure outlined in Equation (2), including year and industry/firm fixed effects, with standard errors clustered at the firm level.

In Table 6, we find evidence of a moderate decline in patent quality per unit of R&D cost for treatment firms following the regulatory change. When the dependent variable is Avg. Citations per Granted Patent, the triple interaction term exhibits a negative coefficient that is moderately significant (t-statistics = 1.55 with industry fixed effects and 1.25 with firm fixed effects). When the dependent variable is Avg. Classes per Granted Patent, the triple interaction term's negative coefficient is statistically significant (t-statistics = 1.92 with industry fixed effects). Specifically, an average increase in ΔTotal_RD is associated with a 1.8% decrease in either forward citations received within ten years or the number of technological classification codes per granted patent.

In contrast, when the dependent variable is patent volume in a firm fixed effects model, the triple interaction term's coefficient is significantly positive. An average increase in ΔTotal_RD is associated with a 2.0% to 2.7% increase in the number of patent applications or patent families. When partitioning the sample by profitability status or by the annual median leverage level, we do not find significant differences, suggesting that our difference-in-differences results are robust to variations in profitability and leverage.

Overall, the opposite signs of the quality and volume effects underscore a tradeoff between innovation quality and quantity attributable to the mandatory R&D expensing regulation. This evidence provides a rare opportunity to observe post-regulation innovation dynamics, particularly given the lack of comparable data following the implementation of SFAS 2 in the United States.

4.5 RELATIONSHIP BETWEEN R&D ACCOUNTING AND STOCK RETURNS

So far, we have analyzed inventing firms' signaling decisions and their corresponding innovation strategies. A small fraction of these firms capitalize R&D costs on their balance sheets as a way to signal high-quality R&D projects. Now, we turn our attention to the equity market as a whole to assess whether signal receivers, in fact, view capitalized R&D as an indicator of high project quality. Specifically, high-quality projects signaled through capitalized R&D should elicit positive market reactions during the pre-regulation signaling equilibrium, compared to projects reflected in expensed R&D. In contrast, after the removal of this key signaling mechanism, investors are no longer able to distinguish high-quality projects, leading to muted reactions to expensed R&D overall.

We test these hypotheses using the constant firm sample with the following OLS model with entropy balancing weights, year and firm fixed effects, and standard errors clustered at the firm level:

$$\begin{aligned}\text{Annual\_Return}_{i,t} = {} & \psi_1\Delta\text{Earnings\_beforeR\&D}_{i,t} + \psi_2\Delta\text{Expensed\_R\&D}_{i,t} + \psi_3\Delta\text{Capitalized\_R\&D}_{i,t} \\ & + \psi_4\Delta\text{Earnings\_beforeR\&D}_{i,t}\times\text{POST}_{i,t} + \psi_5\Delta\text{Expensed\_R\&D}_{i,t}\times\text{POST}_{i,t} + \psi_6\text{TREAT}_{i,t} \\ & + \psi_7\Delta\text{Earnings\_beforeR\&D}_{i,t}\times\text{TREAT}_{i,t} + \psi_8\Delta\text{Expensed\_R\&D}_{i,t}\times\text{TREAT}_{i,t} \\ & + \psi_9\text{POST}_{i,t}\times\text{TREAT}_{i,t} + \psi_{10}\Delta\text{Earnings\_beforeR\&D}_{i,t}\times\text{POST}_{i,t}\times\text{TREAT}_{i,t} \\ & + \psi_{11}\Delta\text{Expensed\_R\&D}_{i,t}\times\text{POST}_{i,t}\times\text{TREAT}_{i,t} + \textstyle\sum y_t\text{Year}_t + \sum d_n\text{Industry}_n + \varepsilon_{i,t} \qquad (5)\end{aligned}$$

We first decompose a firm's annual earnings into earnings before R&D expense and R&D expense itself. During the pre-regulation phase, we also include capitalized R&D costs as incurred, as some firms report these costs on the balance sheet in the year incurred, rather than on the income statement. In the post-regulation phase, only expensed R&D is permitted. We focus on the changes in earnings before R&D expense and R&D expense itself, as the dependent variable,

$Annual\_Return_{i,t}$, reflects the change in equity security prices from year t-1 to year t. Consequently, the coefficients of $\Delta Expensed\_R\&D_{i,t}$ or $\Delta Capitalized\_R\&D_{i,t}$ capture the equity market's response to R&D investments. A coefficient significantly greater than zero indicates that investors value reported R&D investments, whether expensed or capitalized.

We use a similar difference-in-difference design as in Equation (3), interacting the two earnings components with POST and TREAT variables. POST represents the post-regulation period, while TREATment equals one for firms that capitalized R&D costs at least once during the pre-regulation period, as outlined in Table 1, Panel B (the constant firm sample). Entropy balancing is applied in line with the approach used in Table 6.

Results in Table 7 show a significantly positive coefficient for ΔCapitalized_R&D during the pre-regulation period. The statistical significance is modest, reflecting the fact that only 11% of inventing firms chose to capitalize R&D. The standardized coefficient indicates that a one standard deviation increase in ΔCapitalized_R&D corresponds to a 0.013 standard deviation increase in firm annual stock returns, whereas a one standard deviation increase in ΔEarnings_beforeR&D corresponds to a 0.264 standard deviation increase.

Interestingly, there are no significant market reactions to ΔExpensed_R&D for either the pre- or post-regulation periods, across both treatment and benchmark firms. These insignificant coefficients suggest that, in the absence of the capitalized R&D signaling mechanism, investors struggle to differentiate high-quality projects. In response to the loss of this important signal, firms that previously capitalized R&D may shift their innovation strategy away from prioritizing project quality toward emphasizing innovation volume, supported by greater access to debt financing when pooled with firms that had previously expensed R&D.

4.6 RELATIONSHIP BETWEEN R&D ACCOUNTING AND DEBT FINANCING

Our final analysis examines the relationship between R&D reporting and contemporaneous debt financing volume and pricing. This analysis is motivated by the critical role debt financing plays in our firm-level financial strength hypothesis. Because debt holders are primarily concerned with downside risk, they are likely to favor conservative accounting practices, such as the immediate expensing of R&D costs. We test this hypothesis using a constant firm sample, estimating the following OLS model with entropy balancing weights, year and firm fixed effects, and standard errors clustered at the firm level:

$$\text{Debt\_Financing}_{i,t} = \psi_1\Delta\text{Earnings\_beforeR\&D}_{i,t} + \psi_2\Delta\text{Expensed\_R\&D}_{i,t} + \psi_3\Delta\text{Capitalized\_R\&D}_{i,t} + \psi_4\Delta\text{Earnings\_beforeR\&D}_{i,t}\times\text{POST}_{i,t} + \psi_5\Delta\text{Expensed\_R\&D}_{i,t}\times\text{POST}_{i,t} + \psi_6\text{TREAT}_{i,t} + \psi_7\Delta\text{Earnings\_beforeR\&D}_{i,t}\times\text{TREAT}_{i,t} + \psi_8\Delta\text{Expensed\_R\&D}_{i,t}\times\text{TREAT}_{i,t} + \psi_9\text{POST}_{i,t}\times\text{TREAT}_{i,t} + \psi_{10}\Delta\text{Earnings\_beforeR\&D}_{i,t}\times\text{POST}_{i,t}\times\text{TREAT}_{i,t} + \psi_{11}\Delta\text{Expensed\_R\&D}_{i,t}\times\text{POST}_{i,t}\times\text{TREAT}_{i,t} + \sum y_t\text{Year}_t + \sum d_n\text{Industry}_n + \varepsilon_{i,t} \quad (6)$$

Debt financing volume is measured as the sum of bank loans and public bonds, scaled by total assets. Debt financing price is captured by interest expense divided by total liabilities. Results in Table 8 show that ΔExpensed_R&D is significantly positively associated with debt financing volume, but not with the interest expense per yen of liability. Notably, the positive relationship between ΔExpensed_R&D and debt financing volume disappears after the mandatory expensing regulation, as indicated by the negative standardized coefficient on ΔExpensed_R&D×POST (−0.056) relative to the positive standardized coefficient on ΔExpensed_R&D (0.048). These findings suggest that voluntarily expensing R&D indeed facilitated access to debt financing. However, once the mandatory expensing regulation eliminated the signaling value of expensed R&D, creditors could no longer distinguish financially strong firms from others, and thus no longer disproportionately allocated more funding to expensing firms, since all firms were required to expense R&D costs.

5. Conclusion

The traditional theory of innovation financing posits that inventing firms rely first on internal funds and, when necessary, seek external capital—primarily from public equity markets—because knowledge-based intangible R&D assets are generally ill-suited as collateral for debt financing (Brown, Fazzari, and Petersen 2009; Hall and Lerner 2010). However, recent research underscores the growing importance of bank loans and debt financing in supporting innovation (Nanda and Nicholas 2014; Chang, Chen, Wang, Zhang, and Zhang 2019).

Our findings suggest that firms broadly adhere to the theoretical pecking order of financing (Myers and Majluf 1984), prioritizing debt—partly due to its associated tax benefits—before turning to public equity markets. Because creditors are primarily exposed to downside risks, inventing firms often signal financial strength by conservatively expensing R&D in the income statement. Access to debt financing, in turn, enables firms to expand their R&D investment, as evidenced by increases in patent applications and broader patent family coverage.

However, when financially constrained firms are unable to immediately expense R&D or obtain debt financing, they tend to capitalize only high-quality R&D projects to signal value to equity market participants. The possibility of future R&D asset impairments provides equity holders with a mechanism to monitor project progress, thereby encouraging ex ante support for high-risk, high-quality innovation. Our findings—particularly the positive association between R&D capitalization and patent quality, as measured by citations and technological generality—are consistent with U.S.-based evidence that leveraged buyout investments encourage firms to prioritize innovation quality over cost-cutting (Lerner, Sorensen, and Strömberg 2011). They also align with findings by Acharya and Xu (2017), which show that firms in financially constrained industries achieve superior innovation outcomes when accessing public equity markets compared to remaining privately held.

This study contributes to the innovation financing literature by highlighting how financial reporting choices function as signaling mechanisms that shape innovation outcomes. Specifically, we show that the decision to capitalize or expense R&D influences the balance between innovation quality and volume. Future research could extend this analysis by developing structural models to quantify how the mandatory expensing regime under U.S. GAAP may have contributed to the long-term decline in innovation productivity documented by Curtis, McVay, and Toynbee (2020), Bloom, Jones, Van Reenen, and Webb (2020), and Park, Leahey, and Funk (2023). For instance, while Terry (2023) explores the macroeconomic consequences of R&D expensing through the lens of managerial short-termism, future models could incorporate the endogenous choice between capitalization and expensing to capture financial reporting's implications for innovation strategy and productivity.

References

Aboody, David, and Baruch Lev. 1998. "The value relevance of intangibles: The case of software capitalization." *Journal of Accounting Research* 36: 161–191.

Acharya, Viral V., and Zhaoxia Xu. 2017. "Financial dependence and innovation: The case of public versus private firms." *Journal of Financial Economics* 124(2): 223–243.

Anderson, Mark C., Rajiv D. Banker, and S. N. Janakiraman. 2003. "Are selling, general, and administrative costs 'sticky'?" *Journal of Accounting Research* 41(1): 47–63.

Arrow, Kenneth J. 1962. "Economic welfare and the allocation of resources for invention." In *The rate and direction of inventive activity: Economic and social factors*, edited by Richard R. Nelson, 609–626. Princeton, NJ: Princeton University Press.

Baber, William R., Suk Goo Kang, Jonghae Lee, and Joon Park. 2023. "Does capitalization vs. expensing of R&D matter? Evidence from corporate financing decisions and investor valuation." Working paper. Available at https://business.columbia.edu/sites/default/files-efs/imce-uploads/ADP/2023-2024/Baber%20Kang%20Lee%20Park_100123.pdf.

Beaver, William H., and Stephen G. Ryan. 2005. "Conditional and unconditional conservatism: Concepts and modeling." *Review of Accounting Studies* 10(2–3): 269–309.

Bhattacharya, Nilabhra, Yoshie Saito, Ramgopal Venkataraman, and Jeff Jiewei Yu. 2024. "R&D reporting rule and firm efficiency." *Journal of Accounting, Auditing & Finance* 39(2): 335–363.

Bhattacharya, Sudipto, and Jay R. Ritter. 1983. "Innovation and communication: Signaling with partial disclosure." *Review of Economic Studies* 50(2): 331–346.

Bloom, Nicholas, Charles I. Jones, John Van Reenen, and Michael Webb. 2020. "Are ideas getting harder to find?" *American Economic Review* 110(4): 1104–1144.

Brown, James R., Steven M. Fazzari, and Bruce C. Petersen. 2009. "Financing innovation and growth: Cash flow, external equity, and the 1990s R&D boom." *Journal of Finance* 64(1): 151–185.

Campbell, John L., Hsinchun Chen, Yongjian Guan, and Pengfei Ye. 2023. "The amount and quality of R&D capitalization under International Financial Reporting Standards (IFRS)." Working paper. Available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4632001.

Chang, Xin, Yangyang Chen, Sarah Qian Wang, Kuo Zhang, and Wenrui Zhang. 2019. "Credit default swaps and corporate innovation." *Journal of Financial Economics* 134(2): 474–500.

Chuang, Hsin-Chang, Po-Hsuan Hsu, Chung-Ming Kuan, and Jen-Chieh Yang. 2025. "Revamping firm fixed effects models with machine learning: New evidence from recovering the missing R&D-patent relation." Working paper. Available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4636846.

Cohen, Wesley M., Akira Goto, Akiya Nagata, Richard R. Nelson, and John P. Walsh. 2002. "R&D spillovers, patents, and the incentives to innovate in Japan and the United States." *Research Policy* 31(8–9): 1349–1367.

Cohn, Jonathan B., Qiang Liu, and Melanie Wardlaw. 2022. "Lazy prices: The role of firm policies in liquidity provision." *Journal of Finance* 77(5): 2785–2832.

Curtis, Asher, Sarah McVay, and Scott Toynbee. 2020. "The changing implications of research and development expenditures for future profitability." *Review of Accounting Studies* 25: 405–437.

Donelson, Dain C., and Robert J. Resutek. 2012. "The effect of R&D on future returns and earnings forecasts." *Review of Accounting Studies* 17: 848–876.

Financial Accounting Standards Board (FASB). 1974. *Statement of Financial Accounting Standards No. 2: Accounting for research and development costs.* Norwalk, CT: FASB.

Financial Accounting Standards Board (FASB). 1985. *Statement of Financial Accounting Standards No. 86: Accounting for the costs of computer software to be sold, leased, or otherwise marketed.* Norwalk, CT: FASB.

Financial Accounting Standards Board (FASB). 2025. "Invitation to comment—recognition of intangibles." Available at https://www.fasb.org/Page/Document?pdf=ITC%E2%80%94Recognition%20of%20Intangibles.pdf&title=Invitation%20to%20Comment%E2%80%94Recognition%20of%20Intangibles.

Glaeser, Stephen, Mark Lang, James D. Omartian, and Angie Pae. 2025. "Opening the black box of corporate R&D." *Working paper*. Available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5112553.

Granger, Clive W. J., and Paul Newbold. 1974. "Spurious regressions in econometrics." *Journal of Econometrics* 2(2): 111–120.

Hall, Bronwyn H., Adam B. Jaffe, and Manuel Trajtenberg. 2001. "The NBER patent citations data file: Lessons, insights, and methodological tools." *NBER Working Paper* No. 8498.

Hall, Bronwyn H., and Josh Lerner. 2010. "The financing of R&D and innovation." In *Handbook of the economics of innovation*, Vol. 1, edited by Bronwyn H. Hall and Nathan Rosenberg, 609–639. Amsterdam: North-Holland.

Hayek, Friedrich A. 1945. "The use of knowledge in society." *The American Economic Review* 35(4): 519–530.

Iqbal, Aneel, Shivaram Rajgopal, Anup Srivastava, and Rong Zhao. 2025. "A better estimate of internally generated intangible capital." *Management Science* 71(1): 731–752.

International Accounting Standards Board (IASB). 2001. *International Accounting Standards No. 38: Intangible assets.* London, UK: IASB.

Kasahara, Hiroyuki, Koichi Shimotsu, and Michio Suzuki. 2014. "R&D tax credit effects on R&D expenditure: The Japanese R&D tax credit reform in 2003." *Journal of the Japanese and International Economies* 31(1): 72–97.

Kerr, William R. and Ramana Nanda. 2015. "Financing innovation." *Annual Review of Financial Economics* 7(1): 445-462.

Lerner, Josh, Morten Sorensen, and Per Strömberg. 2011. "Private equity and long-run investment: The case of innovation." *Journal of Finance* 66(2): 445–477.

Lev, Baruch, and Theodore Sougiannis. 1996. "The capitalization, amortization, and value-relevance of R&D." *Journal of Accounting and Economics* 21(1): 107–138.

Merton, Robert C. 1974. "On the pricing of corporate debt: The risk structure of interest rates." *Journal of Finance* 29(2): 449–470.

Mohd, Emad. 2005. "Accounting for software development costs and information asymmetry." *The Accounting Review* 80(4): 1211-1231.

Myers, Stewart C. 1977. "Determinants of corporate borrowing." *Journal of Financial Economics* 5(2): 147–175.

Myers, Stewart C., and Nicholas S. Majluf. 1984. "Corporate financing and investment decisions when firms have information that investors do not have." *Journal of Financial Economics* 13(2): 187–221.

Nallareddy, Suresh and Maria Ogneva. 2022. "Capitalization of intellectual property products and distribution of income between labor and capital." Working paper. Available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4056576.

Nanda, Ramana, and Tom Nicholas. 2014. "Did bank distress stifle innovation during the Great Depression?" *Journal of Financial Economics* 114(2): 273–292.

Oswald, Dennis. 2008. "The determinants and value relevance of the choice of accounting for research and development expenditures in the United Kingdom." *Journal of Business Finance & Accounting* 35(1/2): 1-24.

Oswald, Dennis R., Edward Y. Ryu, and Paul Zarowin. 2023. "The effects of capitalization versus expensing on the relevance of R&D information: International evidence." *Working paper*. Available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4300532.

Oswald, Dennis R., Andrew Simpson, and Paul Zarowin. 2022. "Capitalization vs. expensing and the behavior of R&D expenditures." *Review of Accounting Studies* 27: 1199–1232.

Park, Hyunseok, Erin Leahey, and Russell J. Funk. 2023. "Papers and patents are becoming less disruptive over time." *Nature* 613(7942): 138–144.

Resutek, Robert J. 2022. "Is R&D really that special? A fixed-cost explanation for the empirical patterns of R&D firms." *Contemporary Accounting Research* 39(1): 721–749.

Ryu, Edward Y., and Paul Zarowin. 2024. "Can the stock market capitalize R&D expenditures (when firms aren't mandated to)?" Working paper. Available at https://business.columbia.edu/sites/default/files-efs/imce-uploads/ADP/Fall%202024/Ryu%20Zarowin%20202407.pdf.

Schumpeter, Joseph A. 1942. *Capitalism, socialism and democracy.* New York: Harper & Brothers.

Shevlin, Terry. 1991. "The valuation of R&D firms with R&D limited partnerships." *Accounting Review* 66(1): 1–21.

Shi, Charles. 2003. "On the trade-off between the future benefits and riskiness of R&D: A bondholders' perspective." *Journal of Accounting and Economics* 35(2): 227–254.

Solow, Robert M. 1957. "Technical change and the aggregate production function." *Review of Economics and Statistics* 39(3): 312–320.

Sougiannis, Theodore. 1994. "The accounting based valuation of corporate R&D." *Accounting Review* 69(1): 44–68.

Spence, Michael. 1973. "Job market signaling." *Quarterly Journal of Economics* 87(3): 355–374.

Terry, Stephen J. 2023. "The macro impact of short-termism." *Econometrica* 91(5): 1881–1912.

Wasley, Charles E., and Thomas J. Linsmeier. 1992. "Operating income and the SFAS No. 2 R&D reporting standard." *Accounting Review* 67(4): 911–939.

Zheng, Yuxiang. 2025. "Can investors learn from patent documents? Evidence from textual analysis." *Contemporary Accounting Research* 42(1): 503–537.

Figure 1 U.S. Total R&D Expenditures and R&D-to-GDP Ratio (1953-2021)

This figure presents U.S. total R&D expenditures, adjusted to 2017 constant U.S. dollars (in billions), along with the ratio of R&D expenditures to Gross Domestic Product (GDP) from 1953 to 2021. The data for 2021 include estimates that may be subject to later revision. Data source: https://ncses.nsf.gov/data-collections/national-patterns/2021-2022#data.

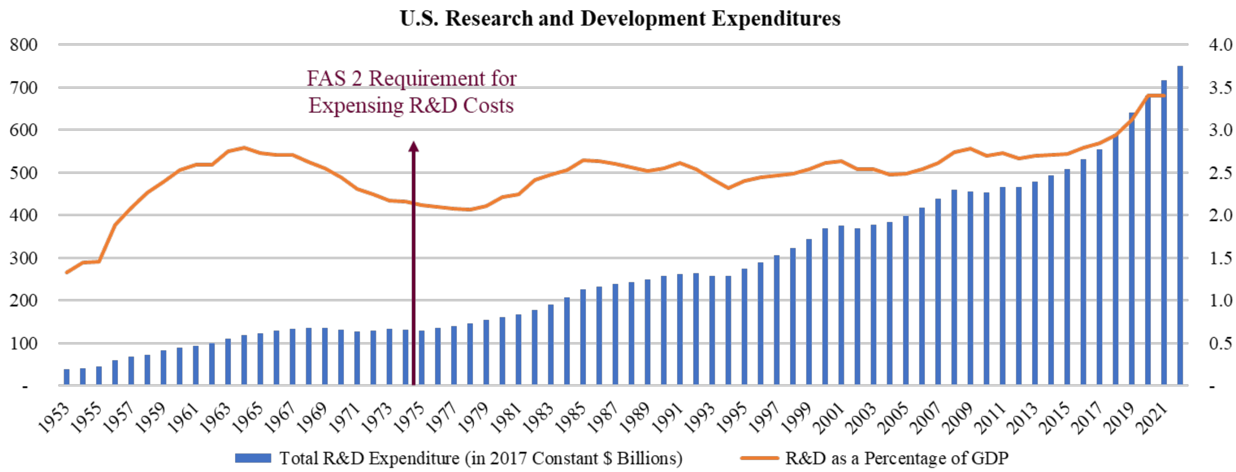
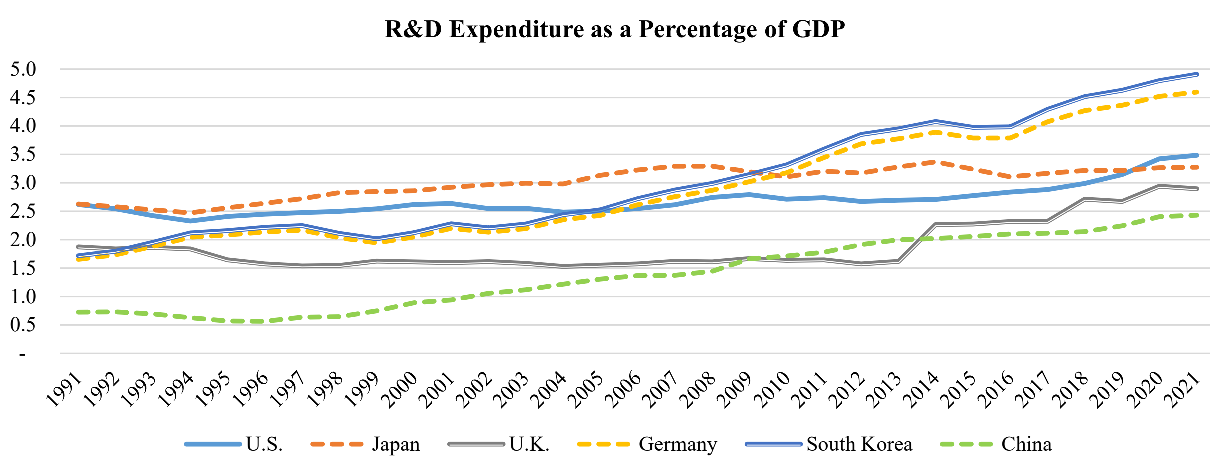


Figure 2 R&D Expenditure-to-GDP Ratios (1991–2021): Comparative Trends in the U.S., Japan, U.K., Germany, South Korea, and China

This figure displays the ratio of R&D expenditures to Gross Domestic Product (GDP) from 1991 to 2021 for the United States, Japan, the United Kingdom, Germany, South Korea, and China. Data source: https://www.oecd.org/en/data/datasets/science-technology-and-innovation-scoreboard.html.



Appendix A Case Studies on Equity Market Reactions to Impairment Announcements

Kaken Pharmaceutical (科研製薬, Security Code: 4521)

On January 5, 1989, Kaken Pharmaceutical announced the discontinuation of its anti-cancer drug development due to R&D setbacks. The company also revealed plans to write down the capitalized R&D assets for the fiscal year ending March 31, 1989. This after-hours announcement led to a significant market response, with the company's stock price, adjusted for overall market movements, declining by 7.43% on the next trading day, January 6.

Nichi-Iko Pharmaceutical (日医工, Security code: 4541)

On December 27, 1996, Nichi-Iko Pharmaceutical announced the discontinuation of a drug development project due to R&D failures, which was accompanied by the impairment of related R&D assets for the fiscal year ending November 30, 1996. In conjunction with this announcement, the company also revised its earnings forecast downward to reflect the impact of the discontinuation. This Friday after-hours announcement triggered a notable market reaction, with the company's stock price, adjusted for overall market movements, declining by 5.62% on the next trading day, December 30.

Taiyo Yuden (太陽誘電, Security code: 6976)

On September 14, 1990, Taiyo Yuden announced the discontinuation of its Video Cassette Recorder (VCR) business unit, which likely led to the impairment of related R&D assets for the fiscal year ending March 31, 1991, based on the year-end balance of those assets. Alongside this announcement, the company revised both its earnings forecast and dividend payout downward to account for the financial impact of the discontinuation. This Friday after-hours announcement led to a significant market reaction, with the company's stock price, adjusted for overall market movements, declining by 4.05% on the following trading day, September 17.

Appendix B Variable Definition

Financial statement data are sourced from the Development Bank of Japan database (https://www.dbj.jp/ricf/databank/), while security prices and other equity market data come from the NPM database by Financial Data Solutions, Inc. (https://www.fdsol.co.jp/npmservices/npmservices-top/). Auditor information from 1990 to 1996 is manually collected from non-financial companies' annual reports, aggregated by I-N Information System Ltd. (https://www.indb.co.jp/english/service/corporate_data/eol/), while data from 2001 to 2007 is obtained from NEEDS by Nikkei Media Marketing Inc. (https://www.nikkeimm.co.jp/service/detail/id=315). Detailed definitions of the variables are provided below.

- Firm size is measured by market capitalization in billions of yen. We apply a logarithmic transformation for the regression analysis to normalize the distribution.

- Market-to-book is defined as the ratio of a firm's market capitalization to its book value of equity, with the condition that the book value of equity must be non-negative.

- Leverage is defined as the ratio of the book value of total liabilities to the book value of total assets.

- Age is calculated as the number of months between the company's incorporation date and the fiscal year-end. We apply a logarithmic transformation for the regression analysis to normalize the distribution.

- Sales growth is calculated as the ratio of the current fiscal year's sales revenue to the previous year's sales revenue.

- Return-on-assets (ROA) is calculated as the ratio of net income for the fiscal year to the book value of total assets at the beginning of the year.

- The loss indicator is set to one when a firm reports negative annual ordinary income from its core operations.

- Big N auditor indicator equals one when a firm is audited by one of the international Big N public accounting firms.

- R&D intensity is defined as the ratio of a firm's R&D expenditures for the fiscal year to the book value of total assets at the beginning of the year. R&D expenditures include both R&D expenses reported on the income statement and estimated capitalized R&D additions recorded on the balance sheet.

- Cash holding is defined as the ratio of a firm's cash balance for the fiscal year to the book value of total assets at the beginning of the year.

- ΔExpensed_RD represents the change in R&D expenses reported on the income statement from fiscal year t-1 to year t, scaled by the book value of total assets at the beginning of the year. The first-order serial correlations of Expensed_RD (i.e., level) and ΔExpensed_RD (i.e., change) are 0.96 and 0.07, respectively, indicating that applying an AR(1) adjustment effectively removes material autocorrelation.

- ΔCapitalized_RD represents the change in capitalized R&D added to the balance sheet from fiscal year t-1 to year t, scaled by the book value of total assets at the beginning of the year. Since only the net book value of R&D assets is reported on the balance sheet, we estimate the annual additions using a five-year straight-line amortization schedule. This approach aligns with the Commercial Code guidelines at the time, which stipulated a maximum amortization period of five years. Furthermore, our review of footnote disclosures confirms that the five-year straight-line amortization is a common practice among firms capitalizing R&D costs. The first-order serial correlations of Capitalized_RD (i.e., level) and ΔCapitalized_RD (i.e., change) are 0.72 and -0.16, respectively, indicating that applying an AR(1) adjustment effectively removes material autocorrelation.

- ΔTotal_RD represents the change in total R&D expenditures from fiscal year t-1 to year t, scaled by the book value of total assets at the beginning of the year. Total R&D expenditures comprise the sum of R&D expenses reported on the income statement and capitalized R&D added to the balance sheet. The first-order serial correlations of Total_RD (i.e., level) and ΔTotal_RD (i.e., change) are 0.84 and 0.08, respectively, indicating that applying an AR(1) adjustment effectively removes material autocorrelation.

Patent data is sourced from the National Institute of Science and Technology Policy (NISTEP). The specific dataset used is the NISTEP Dictionary of Names of Companies (ver. 2023_1), available at http://doi.org/10.15108/data_compdic001_2023_1.

- Avg. Citations per Granted Patent reflects the average number of forward citations received over a ten-year window, starting from the fiscal year in which the change in R&D expenditures (either expensed or capitalized) is measured. The calculation is based on patents granted by the Japanese Patent Office in that same fiscal year.

- Avg. Classes per Granted Patent reflects the average number of technological classification codes listed in patent applications for patents granted by the Japanese Patent Office in the fiscal year corresponding to the change in R&D expenditures (either expensed or capitalized).

- Number of Patents Granted represents the number of patents awarded by the Japanese Patent Office in the fiscal year in which the change in R&D expenditures (either expensed or capitalized) is measured.

- Number of Applications represents the number of patent applications in the fiscal year in which the change in R&D expenditures (either expensed or capitalized) is measured.
- Number of Families represents the number of patent families for the fiscal year in which the change in R&D expenditures (either expensed or capitalized) is measured.

Table 1 Sample Description

Panel A presents the number of firms that either exclusively expense R&D costs, exclusively capitalize R&D costs, or employ both accounting treatments during two distinct periods: the pre-regulation phase (1990-1996) and the post-regulation phase (2001-2007). The comparison illustrates the shift from the pre-regulation environment, where firms had greater discretion in their R&D accounting practices, to the post-regulation period, which mandated the expensing of R&D costs as incurred.

Panel A Accounting Practices for R&D Costs at the Time of Incurrence

	The Benchmark Group	*The Treatment Group*		
	Firms Exclusively Expensing R&D Costs	Firms Exclusively Capitalizing R&D Costs	Firms Both Expensing and Capitalizing R&D Costs	Total
1990	786	39	65	890
1991	823	39	67	929
1992	871	40	74	985
1993	901	35	81	1017
1994	916	36	78	1030
1995	937	38	81	1056
1996	967	41	81	1089
2001	1196			1196
2002	1290			1290
2003	1292			1292
2004	1290			1290
2005	1294			1294
2006	1311			1311
2007	1307			1307
Total	15,181	268	527	15,976

Panel B presents a constant sample of firms, consisting of those with at least one year of observations in the pre-regulation period (1990–1996) and at least one year of observations in the post-regulation period (2001–2007).

Panel B Constant Firm Sample

	Firms that capitalized R&D costs at least once during the pre-regulation period	***Firms NEVER capitalized R&D costs during the pre-regulation period***	Total
1990	83	620	703
1991	85	644	729
1992	89	688	777
1993	92	724	816
1994	90	748	838
1995	89	773	862
1996	93	804	897
2001	89	771	860
2002	87	781	868
2003	85	753	838
2004	82	726	808
2005	81	704	785
2006	81	693	774
2007	78	673	751
Total	1,204	10,102	11,306

Table 1 Sample Description (Cont.)

Panel C presents the distribution of 15,977 firm-years by industry, categorized into two distinct periods: the pre-regulation phase (1990–1996) and the post-regulation phase (2001–2007). Additionally, the panel highlights firm-years associated with patent applications, those that elected to capitalize R&D costs (as shown in Panel A), and those included in the constant firm sample referenced in Panel B.

Panel C Number of Firm-Years by Industry

Number of Firm-Years…	From 1990–1996	From 2001–2007	With Patents	Capitalizing R&D Costs (1990–1996)	In the Constant Firm Sample
Foods, Textiles, and Pulp/Paper	574	568	505	38	811
Chemicals	858	1,054	1,149	90	1,487
Pharmaceuticals	270	312	313	47	492
Petroleum, Rubber, and Steel	227	317	290	39	383
Ceramics	316	325	347	38	515
Non-Ferrous Metal Products	408	539	499	47	689
Machinery	908	1,077	1,177	126	1,509
Electrical Equipment	1,046	1,483	1,399	92	1,839
Automobiles	231	358	314	23	403
Shipbuilding and Transportation Equipment	120	109	91	12	199
Precision Equipment	161	249	224	15	248
Other Manufacturing	198	322	307	21	348
Fishers and Mining	54	63	42	6	80
Construction	871	918	841	38	1,457
Wholesales and Retailers	235	209	121	50	125
Banks, Real Estate, Transportation, and Utilities	197	195	220	49	268
Other Services	322	883	243	64	453
Total	6,996	8,981	8,082	795	11,306

Table 2 Variable Description

This table reports the distribution of variables used in the analysis across two periods: 6,996 firm-years for the full sample during the pre-regulation phase (1990–1996) in Table 1, Panel A, and 5,683 firm-years for the constant firm sample during the post-regulation phase (2001–2007) in Table 1, Panel B. To reduce the impact of outliers and data entry errors, ΔExpensed_RD, ΔCapitalized_RD, and Return-on-Assets are winsorized at the 1st and 99th percentiles annually, while Market-to-Book, Sales Growth, R&D intensity, Cash holding, and patent variables are winsorized at the 99th percentile. Firm size (market capitalization in billions of yen) and firm age (months since incorporation) are log-transformed in the regressions. Avg. Citations per Granted Patent is the average number of forward citations received over a ten-year window, based on patents granted in the same fiscal year as the R&D change. Avg. Classes per Granted Patent is the average number of technological classification codes in those patent granted. See Appendix B for detailed variable definitions.

	Mean	25^{th}	Median	75^{th}	Std	Benchmark Group Mean	Treatment Group Mean	t-statistic for Mean Diff.
				Panel A: Pre-Regulation (1990-1996) N=6,996				
Firm Size	143.5167	16.8228	41.2962	116.5981	331.5230	155.0540	72.8620	7.23
Market-to-book	2.3621	1.4160	1.9346	2.7788	1.5547	2.2940	2.7810	-9.17
Leverage	0.5897	0.4603	0.6015	0.7368	0.1953	0.5790	0.6540	-11.18
Age	617.4750	499.0000	579.0000	725.0000	204.3270	615.3510	630.4860	-2.15
Sales Growth	1.0228	0.9633	1.0214	1.0790	0.1078	1.0230	1.0200	0.93
Return-on-assets	0.0155	0.0056	0.0146	0.0282	0.0293	0.0170	0.0060	11.15
Loss indicator	0.1119	0.0000	0.0000	0.0000	0.3153	0.0980	0.1980	-9.24
Big N auditor	0.7429	0.0000	1.0000	1.0000	0.4371	0.7590	0.6440	7.71
R&D intensity	0.0159	0.0028	0.0087	0.0211	0.0200	0.0160	0.0150	1.49
Cash holding	0.1151	0.0552	0.0953	0.1561	0.0829	0.1170	0.1030	5.10
ΔTotal_RD	0.0007	-0.0007	0.0001	0.0014	0.0038	0.0006	0.0009	-1.88
ΔExpensed_RD	0.0006	-0.0006	0.0001	0.0013	0.0033	0.0006	0.0005	1.54
ΔCapitalized_RD	0.0000	0.0000	0.0000	0.0000	0.0010	0.0000	0.0002	-5.62
Avg. Citations per Granted Patent	0.5145	0.0000	0.0000	0.7778	0.8993	0.5410	0.3540	6.03
Avg. Classes per Granted Patent	0.3728	0.0000	0.0000	0.6176	0.5782	0.3760	0.3540	1.11
Number of Patents Granted	30.4333	0.0000	0.0000	11.0000	106.8516	33.1900	13.5500	5.35
Number of Applications	86.1657	0.0000	0.0000	23.0000	329.3922	93.6560	40.2950	4.71
Number of Families	98.1295	0.0000	0.0000	28.0000	367.5017	106.8210	44.8980	4.90
				Panel B: Post-Regulation Period (2001–2007), Constant Firm Panel N=5,683				
Firm Size	174.5436	8.7200	25.3841	99.6216	539.5304	186.2840	71.8410	4.86
Market-to-book	1.3766	0.6728	1.0692	1.7116	1.0944	1.3420	1.6760	-7.01
Leverage	0.5140	0.3562	0.5193	0.6710	0.2074	0.5060	0.5800	-8.18
Age	724.6400	602.0000	688.0000	837.0000	207.0867	722.779	740.9230	-2.00
Sales Growth	1.0171	0.9555	1.0156	1.0753	0.1399	1.0150	1.0350	-3.32
Return-on-assets	0.0131	0.0029	0.0145	0.0331	0.0458	0.0130	0.0110	1.35
Loss indicator	0.0934	0.0000	0.0000	0.0000	0.2911	0.0900	0.1230	-2.63
Big N auditor	0.7957	1.0000	1.0000	1.0000	0.4032	0.8090	0.6830	7.18
R&D intensity	0.0240	0.0054	0.0159	0.0332	0.0254	0.0240	0.0220	1.54
Cash holding	0.0976	0.0361	0.0732	0.1344	0.0852	0.0990	0.0840	4.02
ΔTotal_RD	0.0005	-0.0010	0.0000	0.0016	0.0051	0.0005	0.0004	0.44
Avg. Citations per Granted Patent	1.8682	0.0000	1.0000	3.2500	2.3374	1.8950	1.6310	2.58
Avg. Classes per Granted Patent	0.4756	0.0000	0.2636	0.8000	0.6134	0.4710	0.5180	-1.74
Number of Patents Granted	77.4429	0.0000	1.0000	30.0000	245.6005	80.8020	48.0580	3.05
Number of Applications	78.5594	0.0000	4.0000	37.0000	227.8066	81.9110	49.2370	3.28
Number of Families	139.9321	0.0000	4.0000	52.0000	440.5386	146.2810	84.3930	3.22

Table 3 Characteristics of Firms Electing to Capitalize R&D Costs (1990–1996)

This table presents the results of a logistic regression model, specified as I[Capitalizing R&D]$_{i,t}$ = $\sum \beta_j$ Firm_characteristics$_{j,i}$ + $\sum y_t$ Year$_t$ + $\sum d_n$ Industry$_n$ + $\varepsilon_{i,t}$, focusing on the pre-regulation period from 1990 to 1996. The analysis is conducted on either the full sample (Table 1, Panel A) or the constant firm sample (Table 1, Panel B). The dependent variable equals one for treatment firms that either exclusively capitalize R&D costs or use both expensing and capitalizing accounting treatments. It equals zero for firms that exclusively expense R&D costs. A few observations are lost due to missing values in firm characteristics. Year and industry fixed effects are included in the regression but omitted from the table for brevity. Standard errors are clustered by firm. *, **, *** denote significance at the 0.10, 0.05, and 0.01 levels, respectively, based on two-tailed tests. For detailed variable definitions, see Appendix B.

Sample:	Full	Constant
Firm size	-0.289***	-0.307***
Market-to-book	0.101**	-0.027
Leverage	1.677***	2.254***
Age	0.209	-0.142
Sales growth	0.546	0.242
Return-on-assets	-7.842***	-6.692***
Loss indicator	0.017	-0.120
Big N auditor	-0.508***	-0.167
R&D intensity	-0.605	6.774
Cash holding	-0.965	-1.735
Pseudo R^2	0.114	0.096
N	6,866	5,441

Table 4 Patent Quality of Capitalized vs. Expensed R&D Projects (1990–1996)

This table presents the results of a Poisson regression model, specified as $Patent\_Quality_{i,t} = \sigma \Delta Expensed\_RD_{i,t} + \gamma \Delta Capitalized\_RD_{i,t} + \sum \beta_j Firm\_characteristics_{j,i,t-1} + Patent\_Quality_{i,t-1} + \sum y_t Year_t + \sum d_n Industry/Firm_n + \varepsilon_{i,t}$, focusing on the pre-regulation period from 1990 to 1996. Patent_Quality is Avg. Citations per Granted Patent or Avg. Classes per Granted Patent. Avg. Citations per Granted Patent represents the average number of forward citations received over a ten-year window, starting from the fiscal year in which the change in R&D expenditures (either expensed or capitalized) is measured. The calculation is based on patents granted by the Japanese Patent Office in that same fiscal year. Avg. Classes per Granted Patent reflects the average number of technological classification codes listed in patent applications for patents granted by the Japanese Patent Office in the fiscal year corresponding to the change in R&D expenditures (either expensed or capitalized). Year and industry/firm fixed effects are included in the regression but omitted from the table for brevity. *, **, *** denote significance at the 0.10, 0.05, and 0.01 levels, respectively, based on two-tailed tests. For detailed variable definitions, see Appendix B.

Dependent Variable (DV):	**Avg. Citations per Granted Patent**				**Avg. Classes per Granted Patent**			
ΔExpensed_RD	-0.897	3.385	-2.362	4.208	-4.813	-4.030	-11.225*	-3.570
ΔCapitalized_RD	48.621**	41.437***	30.385*	45.328***	34.184**	20.095*	14.543	20.851*
Firm size	0.176***	-0.145	0.251***	-0.151*	0.060***	0.044	-0.011	0.040
Market-to-book	-0.035*	0.038	-0.022	0.037	-0.021	-0.026	-0.019	-0.023
Leverage	0.162	0.059	-0.228	0.091	-0.004	0.068	-0.154	0.032
Sales growth	-0.230	0.082	0.313	0.035	-0.097	-0.086	0.127	-0.094
DV (Year t-1)	0.635***	-0.080***			1.006***	-0.087***		
Pseudo-R^2	0.234	0.188	0.107	0.187	0.179	0.110	0.028	0.109
N	6866	3180	6866	3180	6866	3260	6866	3260
Firm fixed effects	N	Y	N	Y	N	Y	N	Y
Industry fixed effects	Y	N	Y	N	Y	N	Y	N
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y

Table 5 Patent Volume of Capitalized vs. Expensed R&D Projects (1990–1996)

This table presents the results of a Poisson regression model, specified as $Patent\_Volume_{i,t} = \sigma \Delta Expensed\_RD_{i,t} + \gamma \Delta Capitalized\_RD_{i,t} + \sum \beta_j Firm\_characteristics_{j,i,t-1} + \sum y_t Year_t + \sum d_n Industry/Firm_n + \varepsilon_{i,t}$, focusing on the pre-regulation period from 1990 to 1996. Patent_Volume is Number of Patents Granted, Number of Applications, or Number of Families. All are from the fiscal year in which the change in R&D expenditures (either expensed or capitalized) is measured and scaled by the beginning-of-the-year book value of total assets. Year and industry/firm fixed effects are included in the regression but omitted from the table for brevity. *, **, *** denote significance at the 0.10, 0.05, and 0.01 levels, respectively, based on two-tailed tests. For detailed variable definitions, see Appendix B.

Dependent Variable (DV):	Number of Patents Granted		Number of Applications		Number of Families	
ΔExpensed_RD	14.294	1.087	22.943**	6.550***	21.876**	5.668***
ΔCapitalized_RD	-13.604	-5.781	-5.619	3.103	-6.583	1.484
Firm size	0.996***	0.111	1.025***	0.055	1.028***	0.150**
Market-to-book	-0.209***	-0.096***	-0.262***	-0.081***	-0.223***	-0.079***
Leverage	1.374***	-0.243	1.615***	-0.324	1.329***	-0.267
Sales growth	-0.367	0.061	-0.503	0.129	-0.488	0.101
Pseudo-R^2	0.669	0.954	0.028	0.109	0.689	0.974
N	6866	3260	6866	3260	6866	3260
Firm fixed effects	N	Y	N	Y	N	Y
Industry fixed effects	Y	N	Y	N	Y	N
Year fixed effects	Y	Y	Y	Y	Y	Y

Table 6 Difference-in-Difference Comparison Between Accounting Regimes

This table reports results from a Poisson regression using the constant firm sample from Table 1, Panel B, after applying entropy balancing. The balancing procedure adjusts for Firm Size, Market-to-Book, Leverage, Age, Sales Growth, Return on Assets, Loss Indicator, Big N Auditor, and R&D Intensity, matching the first three moments of each variable. The model includes a triple interaction term: ΔTotal_RD (change in total R&D expenditures, both expensed and capitalized), POST (an indicator for the post-regulation period), and TREATment (equal to one for firms that capitalized any R&D during the pre-regulation period, as defined in Table 1, Panel B). All other model specifications follow those used in Table 4. Standard errors are clustered at the firm level. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively (two-tailed tests). See Appendix B for detailed variable definitions.

Dependent Variable (DV):	**Avg. Citations per Granted Patent**		**Avg. Classes per Granted Patent**		**Number of Patents Granted**		**Number of Applications**		**Number of Families**	
ΔTotal_RD×POST×TREAT	-26.166	-15.207	-26.324*	10.805	-11.862	10.518	-5.889	39.480***	-6.540	29.563**
ΔTotal_RD×POST	11.435	0.227	19.414**	-0.512	2.149	-4.937	1.008	-18.426***	3.101	-13.267**
ΔTotal_RD×TREAT	29.578**	22.484**	20.574**	0.838	9.212	2.210	13.643	-6.747	13.772	-4.801
ΔTotal_RD	-15.943	-5.555	20.584***	-2.391	-9.051	-0.818	-10.541	6.492	-10.961	4.541
POST×TREAT	0.030	0.029	0.037	0.070	0.095	0.057	-0.106	-0.130	-0.068	-0.065
TREAT	-0.210		-0.088		-0.144		0.031		0.025	
Firm size	0.186***	0.006	-0.080**	0.005	0.997***	0.192*	1.059***	0.294***	1.063***	0.398***
Market-to-book	0.006	0.014	0.060**	0.036	-0.244***	-0.012	-0.293***	-0.069	-0.252***	-0.073
Leverage	-0.404	-0.279	-0.533*	-0.477	2.461***	0.118	2.942***	-0.072	2.702***	0.164
Sales growth	0.165	0.140	0.080	0.005	0.128	0.146	-0.061	-0.189	-0.036	-0.166
Pseudo-R^2	0.176	0.292	0.0528	0.110	0.643	0.901	0.669	0.925	0.664	0.923
N	11250	6861	11273	6966	11273	6966	11291	7081	11291	7081
Firm fixed effects	N	Y	N	Y	N	Y	N	Y	N	Y
Industry fixed effects	Y	N	Y	N	Y	N	Y	N	Y	N
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Table 7 Relationship Between R&D Accounting and Stock Returns

This OLS regression analysis uses the constant firm sample from Table 1, Panel B, after applying entropy balancing. The dependent variable is the annual stock return for firm i in year t, calculated as the cumulative return from nine months before to three months after the fiscal year-end—capturing the typical earnings announcement window. ΔEarnings Before R&D Expense is defined as the change in net income plus expensed R&D, scaled by beginning-of-year total assets. ΔExpensed_RD and ΔCapitalized_RD represent the change in R&D costs recognized on the income statement or capitalized on the balance sheet, respectively. POST denotes the post-regulation period, and TREATment equals one for firms that capitalized R&D at least once during the pre-regulation period (as defined in Table 1, Panel B). Year and industry fixed effects are included but not reported. Standard errors are clustered at the firm level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively (two-tailed tests). For detailed variable definitions, see Appendix B.

Dependent Variable:	**Annual Stock Returns**	
	Coeff	Std Coeff
ΔEarnings before R&D expense	2.756***	0.264***
ΔExpensed_RD	-2.518	-0.026
ΔCapitalized_RD	7.853*	0.013*
ΔEarnings before R&D expense × POST	-0.680**	-0.065**
ΔExpensed_RD × POST	-4.868	-0.051
TREAT	-0.007	-0.019
ΔEarnings before R&D expense × TREAT	-0.349	-0.033
ΔExpensed_RD × TREAT	1.511	0.016
POST×TREAT	-0.022	-0.045
ΔEarnings before R&D expense × POST × TREAT	0.162	0.016
ΔExpensed_RD × POST × TREAT	6.684	0.070
Firm size	-0.030***	-0.074***
Market-to-book	-0.039***	-0.097***
Leverage	0.156***	0.385***
Age	0.023	0.056
Sales growth	0.033	0.082
Return-on-assets	1.614***	3.999***
Loss indicator	0.042*	0.105*
Big N auditor	0.027***	0.067***
Cash holding	-0.249***	-0.616***
Adj. R^2	0.436	0.436
N	11254	11254

Table 8 Relationship Between R&D Accounting and Debt Financing

The OLS regression analysis is conducted using the constant firm sample from Table 1, Panel B, after applying entropy balancing. The dependent variable is either interest expense scaled by total liabilities or the sum of bank loans and public bonds scaled by total assets. POST indicates the post-regulation period and TREATment equals one for firms that capitalized R&D costs at least once during the pre-regulation period, as specified in Table 1, Panel B. Year and industry fixed effects are included in the regression analysis, though their coefficients are not reported. Standard errors are clustered by firm. *, **, *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively, based on two-tailed tests. For detailed variable definitions, see Appendix B.

Dependent Variable:	**Interest Expense**		**Bank Loans & Bonds**	
	Coeff	Std Coeff	Coeff	Std Coeff
ΔEarnings before R&D expense	-2.177*	-0.064*	-0.362***	-0.145***
ΔExpensed_RD	-0.053	-0.003	1.190**	0.048**
ΔCapitalized_RD	-10.495	-0.005	-0.377	-0.002
ΔEarnings before R&D expense × POST	0.116	0.006	0.171	0.058
ΔExpensed_RD × POST	5.248	0.018	-1.374**	-0.056**
TREAT	0.381***	0.306***	0.020**	0.176**
ΔEarnings before R&D expense × TREAT	-0.001	-0.011	-0.166	-0.070
ΔExpensed_RD × TREAT	8.702	0.040	-0.295	-0.011
POST×TREAT	-0.281***	-0.229***	-0.002	-0.016
ΔEarnings before R&D expense × POST × TREAT	0.122	0.015	0.166	0.085
ΔExpensed_RD × POST × TREAT	-13.126	-0.053	0.737	0.019
Firm size	-0.017	-0.013	0.026***	0.341***
Market-to-book	0.028	0.001	-0.007***	-0.005**
Leverage	1.374***	0.237***	0.288***	0.467***
Age	-0.366***	-0.101***	-0.043***	-0.120***
Sales growth	-0.308**	-0.032*	-0.016	-0.024
Return-on-assets	-2.903***	-0.079***	-0.306***	-0.114***
Loss indicator	0.137**	0.137***	0.001	0.011
Big N auditor	0.079	0.062	-0.006	-0.053
Cash holding	-0.968***	-0.065**	0.097***	0.066**
Adj. R^2	0.689	0.688	0.468	0.457
N	11254	11254	11254	11254