The Role of Capital Expenditure in Innovation Investments: Insights from High-Tech Industries

Abstract

This study examines the empirical implications of capitalized R&D embedded within capital expenditures, a component that accounting research often fails to consider due to the challenge in accurately estimating R&D-related capital investments. GAAP states that certain investments in R&D activities be capitalized but does not require firms to partition capital expenditure into R&D-related and non-R&D related. To address the measurement gap in estimating actual capitalized R&D, this study compares high-tech industries, where capitalized R&D likely constitutes a significant portion of capital expenditures, with low-tech industries. The results indicate that capitalized R&D plays a crucial role in corporate innovation. Additionally, the findings reveal a positive interaction between R&D expenses and capital expenditures on future profitability in high-tech industries, suggesting that capitalized R&D enhances the capacity to innovate and strengthens firm performance.

Keywords: research and development (R&D), capital expenditures (CAPX), corporate innovation, patents, future earnings

JEL classification: M41, O32, G30

1. Introduction

Research and Development (R&D) investments capture significant attention across fields such as economics, finance, and accounting due to their critical role in promoting innovation and corporate growth. A large body of literature has focused on innovation investment and find that R&D activities can influence various aspects of a firm, including corporate technological innovation outcomes and financial performance (Pakes & Griliches, 1980; Hausman et al., 1984; Hall et al., 1986; Pavitt, 1982; Sougiannis, 1994; Lanjouw & Schankerman, 2004; Artz et al., 2010; Curtis et al., 2020). However, the input measures in the innovation process in accounting research are limited, most studies exclusively use R&D expenses. Numerous studies operate under the view that all R&D expenditures must be expensed immediately, thus limiting their empirical analysis to R&D expenses recorded in the income statement (Kothari et al., 2002; Lev, 2005; Pandit et al., 2011; Curtis et al., 2020). However, Canace et al. (2018) point out that the reality of firms' annual R&D investments is more complex, including both expensed R&D and capitalized R&D, which is allowed under ASC 730[1], while the expensed R&D is defined as the R&D expenses reported in the income statement, the capitalized R&D specifically refers to the R&D investments that are capitalized as assets on the balance sheets. Given this complexity, Canace et al. (2022) further explore capitalized R&D by presenting interview evidence that it is common and extensive in practice and failure to consider it could significantly impact empirical studies.

Studies in economics have long identified that the investigation of innovation activities requires consideration of both direct knowledge from R&D expenses and indirect knowledge from capital expenditures (Hulten, 1992; Hercowitz 1998; Piergiovanni and

[1] According to the ASC 730-10-25-2a and 2c, the costs of materials, equipment or facilities and the cost of acquiring intangible assets from others are allowed to be **capitalized** as assets if they have **alternative future uses** and will be treated as research and development costs when the material is consumed, or the asset is depreciated.

Santarelli, 2012). For instance, Hall and Ziedonis (2001) show that capital investment strengthens the number of patents issued by semiconductor companies. Piergiovanni and Santarelli (2012) also indicate that capital expenditures play a crucial role in patenting activities of biotechnology firms due to the continuous investments in capital equipment that embody the most advanced technology. However, these economic studies primarily focus on specific science-based industries in earlier periods while the implications of investment in innovative equipment on corporate innovation likely extend beyond these industries due to the significant shift in the economics of innovation in recent years.

The information age revolution has witnessed an exponential increase in computing power, driving transformative changes across various industries. This impact is evident not only in traditional manufacturing industries like biotechnology and semiconductors, but also has introduced possibilities for innovation in other fields that were not available before, such as computing, electronics, and transportation. For example, while the vehicle industry historically conducted some R&D on vehicle performance and design, its demand for R&D was relatively limited due to its status as a mature manufacturing sector. With the rapid technological advancements over the past decade, the industry has now shifted towards autonomous vehicles which heavily rely on real-time data processing, while the research into complex algorithms remains insufficient. This shift has not only led to substantial R&D expenses across various industries but also to increased capital expenditures, driven by continuous investment in updating machinery and capital equipment with cutting-edge technology. Such investments may lead to patentable innovations, as these investments often introduce advanced technological capabilities that can significantly transform existing processes or result in entirely new products. These advancements offer firms competitive advantages through enhanced efficiencies, improved product features, or entirely new market opportunities, all of which are often critical for securing patents. However, previous research on patents has often neglected the impact of capital equipment investment. (Artz et al., 2010; Koh and Reeb, 2015; Sunder et al., 2017) Therefore, I first investigate whether capital expenditure can influence corporate innovation outcomes.

The result indicates that capital expenditure exhibits a positive effect on corporate innovation, specifically measured by patents and citation counts. However, concluding that the observed effect is solely due to the inclusion of capitalized R&D components within capital expenditures may be premature, given that non-R&D elements could also affect innovation outcomes. Accurately estimating the extent of R&D capitalization remains challenging because GAAP does not require firms to separate R&D-related and non-R&D-related components within property, plant, and equipment (PPE) and capital expenditures. To further explore the empirical implications of capitalized R&D and reduce measurement errors, this study next examines how capital expenditures impact high-tech and low-tech industries differentially.

This is because the capital expenditures in high-tech industries are more likely to comprise a significant portion of capitalized R&D due to their innovation dependency and rapid technological changes (Amir et al., 2007; Canace et al., 2022). These industries require continuous advancements and updates in technology to maintain their competitive edge, driving the need to capitalize substantial investments in R&D. In contrast, in industries where the impact of innovation is not dramatic, R&D activities tend to be directed towards making relatively small improvements to existing products rather than achieving breakthroughs, capital expenditures are less likely to be central to R&D activities (Amir et al., 2007). Although such investment may still generate patents, this association tends to be weaker. Therefore, if capitalized R&D indeed has empirical implications, the effect of capital expenditures is expected to vary between high-tech and low-tech industries. As a result, the finding shows that the effect of capital expenditures on patenting outcomes is more pronounced for firms in high-tech industries compared to those in low-tech industries.

The second research question is whether R&D capitalization has an effect on firm's financial performance through R&D expenses. Prior accounting literature primarily examines the impact of R&D treatment on financial performance, like profitability and earnings volatility (Kothari et al., 2002; Amir et al., 2007), as well as its value relevance for investors, such as effects on stock prices (Lev and Sougiannis, 1996; Aboody and Lev, 1998; Gu and Wang, 2005). However, those prior papers often assume constant marginal productivity of R&D, which is unlikely to be the case, as the impact of R&D expenses on firm financial performance can be influenced by various R&D-related characteristics (Ballot et al., 2001; Pandit et al., 2011; Rafiq et al., 2016). For instance, Ballot et al. (2001) find that the association between R&D expenses and future profitability is strengthened when firms have well-trained managers and engineers.

Similarly, investment in innovation equipment can enhance this association by increasing the capacity to innovate, especially in high-tech industries. High-quality and up-to-date assets allow technicians to work more productively, reducing the time and resources required for R&D processes. This, in turn, makes R&D activities more effective, as streamlined operations and advanced tools help transform R&D expenses into profitable outcomes more effectively. The result indicates that the moderating effect of capital expenditure on the association between R&D expenses and future performance is more pronounced in high-tech companies, while the magnitude of this effect is economically large over a five-year horizon. The finding supports the idea that firms in high-tech industries with higher capital investment enhance their profitability by increasing the efficiency of R&D expenses.

In addition, to validate the assertion that a larger proportion of capital expenditures in high-tech industries likely constitutes capitalized R&D compared to low-tech industries. I regress capital expenditures on aggregated future R&D expenses, following SFAS No. 2 guidelines that the depreciation of R&D-related assets should be reported as R&D expenses (Canace et al., 2018). The analysis provides some evidence that there is a stronger integration of capitalized R&D within the capital expenditures in high-tech industries.

This paper makes contributions to two strands of literature. First, the accounting literature on corporate innovation focuses almost exclusively on the effect of R&D expenses on corporate innovation outcomes, while this is limited recognition of the importance of capital expenditure. This paper underscores the importance of considering the empirical implications of capitalized R&D, by demonstrating that the capital expenditure is associated with higher patent and citation counts. Further, the results show that capital expenditure in high-tech industries, which comprise a significant proportion of capitalized R&D in their capital expenditures, are associated with higher patent and citation counts compared to those in low-tech industries, where capitalized R&D plays a lesser role in their capital expenditures. Second, this paper is related to the studies that examine the effect of R&D expenses on firms' future performance (Kothari et al., 2002; Chambers et al., 2003; Amir et al., 2007; and Curtis et al., 2020). The finding adds to this literature by showing that the investment in innovative capital equipment makes R&D expenses more impactful on future performance.

The remainder of the paper is organized as follows. Section 2 discusses the literature review and hypothesis development. Section 3 describes sample selection, research design, and summary statistics. Section 4 presents the empirical results. Section 5 illustrates the additional tests. Section 6 concludes.

2. Literature Review and Hypothesis Development

2.1 R&D investment and Patenting Activities

R&D and patenting are viewed as different aspects of the same process of firm innovation. Many studies use R&D expense as a proxy for innovation inputs to investigate its impact on corporate innovation outcomes. Generally, these studies demonstrate a positive relationship between R&D expenses and patenting activities, with ongoing enhancements in the methods used to measure innovation outputs (Kortum, 1997; Lanjouw and Schankerman, 2004; Artz et al., 2010). Early work by Pakes and Griliches (1980) establish patent filings as a reliable indicator of innovation, documenting a positive relation between R&D expense and the number of patents filed. This idea is further supported by Pavitt (1982), who show that R&D expenses are positively correlated to the patenting activities, including patents filed and granted. Lanjouw and Schankerman (2004) further refine the measurement method by developing a patent quality index that incorporates the number of patent claims, citation counts, and patent family sizes, and suggest that high-quality patents are associated with lower patent counts per unit of R&D expenses, highlighting that the adjustments for patent quality can reveal a more comprehensive picture of innovation effectiveness.

While the methods for assessing innovation outcomes have progressively improved, the input measures of innovation still primarily focus on R&D expenses. However, Koh and Reeb (2015) suggest that the traditional measure of R&D expenses does not fully capture the breadth of innovation activities within firms. The authors show that firms with unreported R&D activity, referred to as "missing R&D firms," not only file for and receive patents but do so at significantly higher rates than firms that report zero R&D expenses. Moreover, these missing R&D firms are more likely to begin reporting R&D expenses after experiencing an exogenous auditor change[2]. Their findings suggest that low or absent R&D expenses do not necessarily represent a lack of innovation in a company. Instead, it reflects strategic reporting behaviours that are motivated by managers' desire to maintain competitive advantages and innovation strategies from competitors, due to the high proprietary costs of disclosing comprehensive R&D investments (Artz et al., 2010; Glaeser and Lang, 2023).

Furthermore, Canace et al. (2020) point out that a portion of total R&D investment might not appear explicitly as R&D expenses but instead is capitalized as part of property, plant, and equipment (PPE). This practice of R&D capitalization is both common and extensive in reality, with interview evidence indicating that 22% of R&D investments are capitalized annually. The capital expenditures include not only investments in non-R&D tangible assets but also significant investments in R&D equipment. This idea is indirectly supported by Canace et al. (2018), who found that when companies earn less than expected, they tend to cut R&D expenses and increase capital expenditures, while this increase in capital expenditures likely represents additional capitalized R&D[3]. These findings collectively show that capital expenditures indeed contain certain investments in R&D-related assets. However, prior literature often fails to consider these aspects when examining the effects of corporate innovation. Typically, the control variables used are also limited and rarely include capital expenditures, which may lead to an incomplete understanding of how such investments impact innovation outcomes. This is particularly critical because capital expenditures, including those on R&D-related assets, play a critical role in supporting sustained innovation activities. Investments in the latest technology and equipment can

[2] The exogenous auditor change is due to the rapid demise of Arthur Andersen (AA), the change in auditor was forced upon its clients

[3] The increased amount of capital expenditure is positive associated with the future R&D expenses instead of depreciation expense, because the depreciation in R&D related assets will flow into income statement in the future as R&D expenditures rather than as depreciation expense

directly contribute to enhanced research capabilities and innovative outputs. Therefore, the hypothesis is developed as follows.

H1a: There is a positive association between capital expenditure and corporate innovation outcomes.

Economics research has long highlighted the role of capital equipment investment as a crucial input for innovation efforts in specific science-based industries (Hercowitz, 1998; Piergiovanni and Santarelli, 2012). In high-tech companies, maintaining a competitive edge requires continuous technological advancements and product updates. The ongoing innovation requires not only the expenditures such as labour costs or contract expenditures that are usually reported as R&D expense, but also substantial investments in new capital equipment or upgrading of existing equipment to incorporate the most advanced technologies, which are typically reported as capital expenditures (Hulten, 1992). The investment in such advanced equipment is often costly because high-tech products are always sophisticated and require high levels of precision, which typically drives a high proportion of capital expenditures towards investments in R&D-related machinery and equipment.

Consistent with this argument, Piergiovanni and Santarelli (2012) document that the innovative output of science-based firms is driven by both R&D expenses and capital expenditures. Similarly, Canace at el. (2020) also restrict the sample to high-tech industries and measure the total R&D investments as the combined total of R&D expenses and capital expenditures. This approach acknowledges that a significant portion of capital expenditures could essentially be regarded as capitalized R&D in the industries that heavily rely on sophisticated technological equipment to drive innovation. Conversely, the nature of innovation in low-tech industries is often based on modifying existing technologies or integrating them with new high-tech components (Hartmut Hirsch-Kreinsen, 2014). Such innovation may emphasize on process improvements, minor modifications, or cost reductions, which do not generally meet the novelty criteria required for patenting.

Based on the understanding that a significant portion of R&D investment is captured within capital expenditures and that these investments are vital for innovation, especially in high-tech industries, the hypothesis is proposed as follows:

H1b: The positive relation between capital expenditure and corporate innovation outcomes is pronounced for companies in high-tech industries.

2.2 R&D investments and Future Profitability

Although the innovation process is highly complex and uncertain, it has been well-documented that firms with higher levels of investments in their innovations are likely to exhibit future performance growth (Lev & Sougiannis, 1996; Donelson & Resutek, 2012; Curtis et al., 2020). However, R&D expenses are also associated with greater future earnings volatility than capital expenditures. This is because successful R&D can lead to significant positive earnings growth, whereas failures may result in substantial negative earnings impacts (Kothari et al., 2002; Amir et al., 2007).

While most studies use R&D expenses as a proxy for a firm's research intensity, the marginal benefits of R&D are assumed to be constant across firms, which may not accurately capture the variability in R&D efficiency among different companies (Pandit et al., 2011). Some studies find that the impact of R&D expenses on firm financial performance can be influenced by other R&D-related characteristics (Ballot et al., 2001; Rafiq et al., 2016). For instance, Ballot et al. (2001) demonstrated that, for firms in France, the positive association between R&D expenses and firm's productivity is complemented by the training for managers and engineers. The finding suggests that training programs can enhance the skills of these key personnel, thereby enabling firms to leverage their R&D investments more effectively.

Building on the understanding that the effect of R&D expenses on a firm's performance may vary with other R&D-related factors, I infer that, for firms concurrently invest in upgrading their capital equipment, their R&D activities are more adept at transforming new ideas into marketable products. Advanced R&D infrastructure, such as modern laboratories, specialized equipment, and data analytics tools, facilitates more effective application of research discoveries. This not only speeds up experimentation processes but also enables more precise and scalable research activities, thereby boosting the innovation process in industries such as biotechnology, electronics, and pharmaceuticals. This complementarity between capital expenditure and R&D expenses may be particularly pronounced in high-tech industries due to the higher sensitivity to efficiency gains. In high-tech industries, where R&D represents a substantial portion of total costs, even small improvements in R&D efficiency can lead to significant cost savings and faster product development cycles. Up-to-date equipment enhances productivity, enabling firms to bring innovations to market more quickly, which is crucial in competitive, fast-moving markets. Therefore, those firms with higher capital expenditures are likely to generate greater future profits from their R&D expenses due to improved operational efficiencies and potentially faster implementation of R&D findings. Given this argument, the second hypothesis is developed as follows:

H2: For firms in high-tech industries, the association between R&D expenses and future profitability can be moderated by capital expenditures.

3. Sample Selection and Research Design

3.1 Sample Selection

The sample comprises U.S. public firms listed on the NYSE, Amex, or NASDAQ. Financial statement data is obtained from Compustat, and data on mergers and acquisitions is sourced from SDC Platinum, covering the period from 1980 to 2019. Patent information is drawn from the KPSS2017 database. All firm-year observations in the study have positive R&D expenses, sales, and total assets. Additionally, firms must have non-missing book-to-market ratios and net income. Following the data processing method by Curtis et al. (2020), other missing values are replaced with zeros. Firms in the financial service (SIC between 6000 and 6999) and utility (SIC between 4900 and 4999) industries are excluded due to their distinct regulatory and financial environments. To mitigate the influence of outliers, all continuous variables are winsorized at the 1^{st} and 99^{th} percentile.

Finally, nine industries are classified as high-tech industries based on 2-digit SIC codes following Canace et al. (2020). These include: 28 (Chemicals and Allied Products), 35 (Industrial and Commercial Machinery and Computer Equipment), 36 (Electronic and Other Electrical Equipment and Components, Except Computer Equipment), 37 (Transportation Equipment), and 38 (Instruments and Related Products). This set of industries encompasses nine distinct sectors, representing a comprehensive classification of high-tech industries.

3.2 Research Design

3.2.1 Corporate Innovation Model

Following Sunder et al. (2017), two metrics are used to proxy for the firm's innovation outcomes. The first metric is a simple count of the number of patent applications that are filed for each firm-year, which is used to proxy for the quantity of innovation outcomes. The second metric is the number of citations subsequently received by the patents applied for in a given year. The model is specified as follows:

$$\log(Inno)_{t+1,t+i} = \beta_0 + \beta_1 RDEXP_t + \beta_2 CAPX_t + \beta_3 RDEXP_t \times HighTech \\ + \beta_4 CAPX_t \times HighTech + Controls + \varepsilon_t \quad (1)$$

where $Inno$ stands for the corporate innovation outcomes, which is measured by the natural logarithm of patent counts (log $(PAT)_{t+1,t+5}$) and the natural logarithm of adjusted forward citation counts (log $(Adj.CIT)_{t+1,t+5}$) summed over years t+1 to t+5. The indicator variable $HighTech$ equals to one if the firm is in a high-tech industry and zero otherwise. Two interaction terms ($RDEXP_t \times HighTech$ and $CAPX_t \times HighTech$) are included to explore the incremental impact of R&D expenses and capital expenditure in high-tech industries.

The dependent variables face two truncation issues. The first truncation problem arises with patents that have submitted the application but have not been granted yet; these are not included in the dataset[4]. For example, since the dataset end in 2023, so those patents that applied for in 2023 but granted in 2024 are not included in the dataset, which affects the accuracy of patent count metrics. To address this truncation issue, the sample period is ended in 2019, following the methodologies proposed by Hall et al. (2001; 2005) and Sunder et al. (2017). The second truncation issue is encountered by citation counts. The citation counts for each patent reflect the total number of citations from the granted year to the year 2023. As a result, patents that were granted more recently generally have fewer citations compared to those granted in earlier years due to less time being available for accumulating citations. To address this bias, the citation counts are adjusted using the “time-adjusted” approach pioneered by Hall et al. (2001) and Jaffe and Trajtenberg (2001). The adjusted citation

[4] The patent data is drawn from KPSS2017, which contains both the filing and granted dates for each observation. This dataset excludes applications that have not resulted in granted patents, while there are alternative datasets that include all patent applications, irrespective of their eventual grant status. However, the alternative dataset only contain data up to 2010. In contrast, KPSS2017 provides updated information extending to 2023, offering a more current perspective on patenting activities.

($Adj.CIT$) is calculated by dividing the total number of citations received for granted patents applied for in year t for firm f by the average number of citations received by other firms in the same year:

$$Adj.CIT = \frac{Citation_{f,t}}{\sum Citation_{f,t} / N_t}$$

where $Citation_{f,t}$ is the total citations received for by all the granted patents applied by firms in year t[5]. N_t is the total number of granted patents applied for in year t. Furthermore, patent counts and citation counts are in the natural logarithm of one plus patent or citation counts to keep the observations with zero citation.

Some cited firm characteristics may influence a firm's patenting activities. Following the prior literature (Lerner and Seru, 2021; Chen et al., 2023), firm size (SIZE), financial leverage (LEV), Market-to-Book ratio (MB), cash holding (CASH) are included as control variables. See Appendix for detailed variable definitions.

3.2.2 Future Profitability Model

To test the second hypothesis, which explores the differential impacts of R&D and capital expenditures on future adjusted net income across high-tech and low-tech industries, a model developed by Curtis et al. (2020) is used by including an extra interaction term to specifically investigate the combined influence of R&D expenses and capital expenditures:

$$Adj.NI_{t+1,t+i} = \beta_0 + \beta_1 RDEXP + \beta_2 CAPX + \beta_3 RDEXP \times HighTech + \beta_4 CAPX \times HighTech + \beta_5 RDEXP \times CAPX \times HighTech + Controls + \varepsilon \quad (2)$$

where $Adj.NI_{t+1,t+i}$ represents the sum of adjusted net income from fiscal year t+1 to t+i. The future net incomes are adjusted for R&D expenses, advertising expenses, and

[5] The analysis focuses on the number of patents applied for in year t, rather than the number granted in year t. However, because the dataset only includes patents that were eventually granted, they are referred to here as "granted patents applied in year t."

depreciation expenses. The three-way interaction term ($RDEXP \times CAPX \times HighTech$) is specifically designed to investigate whether the combined effect of R&D expenditures and capital expenditures on adjusted net income is different in high-tech industries compared to low-tech industries. This coefficient is expected to be positive, as in high-tech industries, where technological advancements and innovation are rapidly evolving, the efficient integration of R&D outputs into productive capital can significantly enhance the future profitability.

Several control variables are included to account for the relevant financial, operational, and market-related factors that influence firm performance. First, advertising expenses (ADV_t), and selling, general, and administrative expenses, excluding R&D expenses and advertising expenses ($NETSGA_t$) are controlled to capture firm's strategic financial investments and operational spending. Mergers and acquisitions ($M\&A_t$) is included to account for the acquired innovation. Additionally, the adjusted net income for year t ($Adj.NI_t$) and the change of adjusted net income ($\Delta Adj.NI_t$) are included to control for profitability trends and their persistence. Lastly, the Book-to-Market ratio (BM) is used to adjust for external market factors. See Appendix for detailed variable definitions.

3.3 Summary Statistics

Table 1 provides descriptive statistics for the sample drawn from high-tech and low-tech industries over the period from 1980 to 2019. Panel A presents the sample in high-tech industries while the sample for low-tech industries is presented in Panel B. In the high-tech industries (Panel A), R&D expenses show a considerable average of 0.1213, and the innovation outcomes are also substantial, as measured by the mean values of patent counts and citation counts (e.g., $\log(pat)_{t+1,t+5}$ at 4.7569 and $\log(adj.cit)_{t+1,t+5}$ at 4.5051), reflecting the importance of technological advancements in high-tech industries. Comparatively, the low-tech industries (Panel B) exhibits slightly lower innovation outputs, with patents and citations means smaller than those in high-tech industries (log(pat)$_{t+1, t+5}$ at 4.7425 and log(adj.cit)$_{t+1, t+5}$ at 4.5006), while the adjusted net income over five years and size are higher in low-tech industries, with an Adj.NI$_{t+1, t+5}$ mean of 1.0618 and a SIZE mean of 5.8039, compared to the high-tech industries, where mean values are 0.9291 for adjusted net income and 5.3037 for size, suggesting low-tech industries may benefit from different operational efficiencies and financial structuring. In addition, both types of industries show similar financial and operational metrics, such as market-to-book ratios and leverage, indicating comparable market perceptions and financial structures across different technological intensities.

———————— Insert Table 1 Here ————————

4. Empirical Results

4.1 Corporate Innovation

Table 2 reports the results examining the impact of R&D expenses and capital expenditure on patent and citation counts across high-tech and low-tech industries. Panel A focuses on the aggregated number of patents filed in the years following investment, capturing the immediate output of innovation efforts. Conversely, Panel B presents the adjusted citation counts for these patents, offering insight into their quality. Column (1) to (3) present the results of Eq(1), $RDEXP$ and $CAPX$ are included individually to assess their impact on the level of future patenting activities, Column (4) to (6) present the estimates from Eq(2), where the interactions with the indicator variable of high-tech industries are also included to examine whether there is significant difference of the effect of R&D expenses and capital expenditures on patenting activities between two types of industries.

In Table 2, where the dependent variables are the total number of granted patents applied for in the next year, next three years and next five years, the coefficients of $RDEXP$ and $CAPX$ in column (1) to column (3) are positive and highly significant across all future periods. Specifically, in column (1) of panel A, one standard deviation increase in R&D expenses is associated with 39.24% ($(e^{2.508\times0.132} - 1) \times 100\%$) increase in the number of patents, and one standard deviation increase in capital expenditure corresponds to 8.21% rise in the number of patents, calculated as $(e^{1.754\times0.045} - 1) \times 100\%$). The results in columns (1) to (3) of Panel B are consistent with Panel A, where the dependent variables are substituted by citation counts. One standard deviation increase in R&D expenses results in 39.35% ($(e^{2.514\times0.132} - 1) \times 100\%$) increase in the number of adjusted citation counts, and one standard deviation increase in capital expenditure is associated with 14.11% ($(e^{2.934\times0.045} - 1) \times 100\%$) increase in the number of adjusted citations. These results show that both R&D expenses and capital expenditures play essential roles in driving sustained corporate innovation.

In columns (4) to (6) of Table 2, where two interaction terms $HighTech \times RDEXP$ and $HighTech \times CAPX$ are included, the coefficients of $RDEXP$ still demonstrate a significant and substantial positive effect on patents counts (Panel A) and citation counts (Panel B), while the interaction term $HighTech \times RDEXP$ is generally negative and insignificant across all columns in both panels. In contrast, the main effect of capital expenditures ($CAPX$) in columns (4) to (6) becomes insignificant, with coefficients near zero or slightly negative, while the interaction term $HighTech \times CAPX$ reveals a consistently positive and significant effect at 95% level over different time horizons. The effect of capital expenditure in high-tech industries is larger over the longer time horizons. The coefficients range from 1.949 to 2.804 for patent counts and from 2.074 to 3.086 for citation counts. This finding indicates that the nature of capital expenditures may vary across different types of industries, supporting the first hypothesis that the positive association between capital expenditure and corporate innovation is more pronounced for firms in high-tech industries.

In summary, the results in table 2 support the argument that capital investments in high-tech industries are likely to be more strategically aligned with innovation activities, including the acquisition of advanced technologies, specialized equipment, or other assets that directly contribute to innovation outcomes, and therefore, have a significant long-term impact on enhancing both the quantity and quality of innovations.

——————— Insert Table 2 Here ———————

4.2 Future Profitability

Table 3 provides the results of Eq(3), which is developed from the model in Curtis et al. (2020), showing an analysis of the effect of R&D expenses ($RDEXP$) and capital expenditure ($CAPX$) on future profitability. It specifically examines how the combined effects of R&D and capital investment differ between high-tech and low-tech industries by incorporating the three-way interaction term. The coefficient for $HighTech \times RDEXP \times CAPX$ at year t+1 is 0.953 with an insignificant t-statistic of 1.578. However, this interaction term escalates significantly to 6.564 and 11.900 in the three-year and five-year periods, respectively, with t-values at conventional level. The result suggests that in high-tech industries, the synergistic impact of integrating R&D expenses with capital investments becomes more pronounced over time. Initially, the combination of these investments may not impact profitability; however, as firms continue to develop and integrate their technological advancements with supportive capital infrastructure, the combined effects start generating substantial profitability gains. Although previous studies rarely focused on this long-term implication, the delayed but powerful return on combined investments in high-tech industries underscores the importance of sustained strategic investment in advanced equipment and infrastructure to realize potential benefits.

Additionally, across all columns of Table 3, the coefficients of R&D expenses ($RDEXP$) and capital expenditures ($CAPX$) are both consistently positive and significant at the 99% level, consistent with the findings by Curtis et al. (2020). It is also noticeable that the impact of R&D expenses on future profitability demonstrates a consistent negative trend over time in high-tech industries. At the year t+1, the coefficient of $HighTech \times RDEXP$ is -0.267 with a t-statistic of -4.876. This negative effect deepens to -1.047 (t-statistic = -3.848) at three-year period, and further to -1.932 (t-statistic of -3.093) at five-year period, indicating that the incremental benefits of R&D in high-tech industries may not be as substantial as in low-tech industries.

———————— Insert Table 3 Here ————————

5. Additional Tests

5.1 Capitalized R&D in different industries

Thus far, the results show that the capital expenditures for firms in high-tech industries not only improve corporate innovation outcomes but also enhance the efficiency of R&D expenses in fostering future profitability. All the above analysis operates under the assertion that high-tech industries have a significantly larger proportion of capitalized R&D within capital expenditures compared to low-tech industries. However, it is possible that the effect of capitalized R&D acts differently in different industries. In low-tech industries, for instance, capital expenditures may still encompass a significant amount of capitalized R&D, albeit without a marked impact on innovation outcomes and future income.

Therefore, to further validate the argument that high-tech industries have a significantly larger proportion of capitalized R&D within capital expenditures compared to low-tech industries, I modify the model developed by Canace et al. (2018) and regress capital expenditures on aggregated R&D expenses over the next five years. This approach follows the guidelines of SFAS No. 2, which stipulate that the depreciation of capitalized R&D assets must be reported as R&D expenses, whereas the depreciation of non-R&D assets is generally reported under depreciation expenses. If a substantial portion of capital expenditures belongs to capitalized R&D, these investments will eventually appear in the income statement as future R&D expenses. Thus, a stronger positive association between future aggregated R&D expenses and current capital expenditures is expected in high-tech industries, where a larger share of capital investments is likely devoted to R&D assets.

The results in table 4 confirm that while capital expenditures in low-tech industries are related to aggregated future R&D expenses, with a coefficient of 0.345 and t-statistics of 2.033, this association is more pronounced in high-tech industries. The interaction term $HighTech \times CAPX$ has a coefficient of 0.390, which, though only marginally significant (t=1.790), suggests high-tech firms are more likely to capitalize R&D within their capital expenditures.

———————— Insert Table 4 Here ————————

5.2 The declining implication of R&D expenses in high-tech industries.

The results in table 3 reveal an unexpected negative relationship between R&D expenses ($HighTech \times RDEXP$) and future profitability in high-tech industries, prompting a further investigation of this finding. Curtis et al. (2020) found that there is a declining implication of R&D expenses for future profitability due to various reasons, such as changes in the nature of R&D projects and a shift in the types of firms undertaking R&D. To further investigate the potential causes of the decrease in R&D profitability, I replicate the study by Curtis et al. (2020) using the same model and sample period from 1980 to 2012. The results in column (1) are closely align with the original study, displaying consistent signs and significance across variables. Despite a slight variation in the magnitude of coefficients, likely due to approximately 2,000 fewer observations in the current sample, the replication effectively confirms the robustness of the original findings. When the sample period expands to 2019, the result differs, as shown in column (2) of Panel A. The significance of the $RDEXP$ coefficient becomes lower, suggesting that the positive effect of R&D on future profitability may have weakened over time, which is also consistent with the argument in Curtis et al. (2020) showing that the implication of R&D expenses is decreasing over time. However, when the sample in column (2) is divided into high-tech and low-tech industry subsamples, as displayed in columns (3) and (4), the coefficient for R&D expenses ($RDEXP$) in high-tech industries is 0.135 with a t-statistic of 0.752, which is not statistically significant. In contrast, for low-tech industries, the $RDEXP$ coefficient is positive and significant (coefficient = 1.327, t-statistic of 2.640). One possible explanation for this disparity is that the fast obsolescence of existing technology and more rapid shifts in industry paradigms within high-tech industries that could damage the impact of R&D investments on long-term profitability.

To further examine this temporal shift in the R&D-profitability relationship, I applied a model incorporating a time trend as outlined in Curtis et al. (2020), with the results presented in Panel B. The findings indicate that the observed decline in the impact of R&D expenses on future profitability is primarily driven by high-tech industries, where R&D investment shows a diminishing association with profitability over time. In column (3) of Panel B, the coefficient for the interaction term **(**$Trend \times RDEXP$**)** is -0.095, which is significant with a t-statistic of -5.193. This negative interaction term suggests that the positive impact of R&D expenses on future profitability decreases specifically within high-tech industries over time, while R&D expenses in low-tech industries maintain a more stable positive association with future profitability. The declining trend in high-tech industries further suggests that rapid technological obsolescence, which is driven by the increasingly intense competition in recent years, may weaken the relationship between R&D expenses and profitability within high-tech industries. This competitive environment may compel companies to continuously innovate, potentially shortening the lifecycle of new technologies and reducing the time frame for recovering R&D investments.

In short, the finding in Table 5 aligns with the insignificant $RDEXP$ coefficient observed in high-tech industries in Table 3 and provides insights into how the economic value of R&D investment may vary across industries and evolve over time.

——————— Insert Table 5 Here ———————

6. Conclusion

Given the significance of R&D investments in firms' investment portfolios, it is important for financial statement users to understand the implications of capitalized R&D for corporate information and financial outcomes. The study provides evidence that the capital expenditures significantly contribute to corporate innovation, as evidenced by higher patent and citation counts, with these effects being more pronounced in high-tech sectors where capitalized R&D likely constitutes a larger share of total capital expenditures. Furthermore, the positive interaction between R&D expenses and capital expenditures on future profitability suggests that capitalized R&D enhances firms' innovation capabilities, thereby improving long-term financial performance. These findings are validated by examining the differential impact of capital expenditures in high-tech versus low-tech industries. Capital expenditures in high-tech industries closely align with future R&D expenses, suggesting a larger R&D component in their capital investments, while this association is weaker in low-tech industries. Collectively, this paper highlights the importance of considering capitalized R&D in empirical studies to fully capture its implications for corporate innovation and financial outcomes across industries.

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Appendix A

Variable Definition

$\log(pat)_{t+1,\ t+i}$	Natural logarithm of one plus the aggregated number of patents from fiscal year t+1 to t+i
$\log(adj.cit)_{t+1,\ t+i}$	Natural logarithm of one plus the aggregated adjusted number of citations from fiscal year t+1 to t+i
$Adj.NI_{t+1,\ t+i}$	Aggregated future adjusted net inome from t+1 to t+5, scaled by total assets.
RDEXP	R&D expenses scaled by total assets. (Compustat: XRD / AT)
CAPX	Capital Expenditure scaled by total assets. (Compustat: CAPX / AT)
MTB	Market to Book Ratio, calculated as market value of equity scaled by book value of equity (Compustat: PRCC_F × CSHO / CEQ)
LEV	Sum of book value of short-term and long term debts scaled by total assets (Compustat: (DLTT+DLC) / AT)
CHE	Sum of cash and short-term investments scaled by total assets (Compustat: CHE / AT)
SIZE	Natural logarithm of total assets
SGA	Selling, general, and administrative expenses, adjusted for R&D and advertising expenses, scaled by total assets (Compustat: (XSGA - XRD - XAD) / AT)
AD	Advertising expenses scaled by total assets (Compustat: XAD / AT)
M&A	Mergers and acquisitions scaled by total assets
Adj.NI	Net inome adjusted by R&D expenes, advertising expenses, and depreciation expenses, scaled by total assets. (Compustat: (NI + XRD + XAD + DP) / AT)
ΔAdj.NI	Change in adjusted net inome scaled by total assets. (Compustat: ($Adj.NI_t$ - $Adj.NI_{t-1}$) / AT)
BM	Book-to-market ratio, calculated as the book value of common equity plus the deferred Taxes and Investment Tax Credit, divided by the market value of common equity (Compustat items (CEQ + TXDB) / (PRCC_F × CSHO))
DVT	Total Dividend Paid scaled by total assets (Compustat: LEV / AT)
MB	Market to Book ratio following Canace et al (2020), calculated as the market value of common equity plus the book value of assets minus the book value of equity scaled by total assets (Compustat: (PRCC_F × CSHO + AT - CEQ) / AT)
FINCF	Cash flow from financing activities scaled by total assets. (Compustat: FINCF / AT)
CFO	Cash flows from operations scaled by total assets (Compustat: OANCF / AT)
ΔSALE	year-over-year difference in sales scaled by total assets. (Compustat: ($SALE_t$ – $SALE_{t-1}$) / AT)

TSTK	the dollar amount of treasury stock scaled by total assets. (Compustat: TSTK / AT)
AQC	Acquisitions scaled by total assets (Compustat: AQC / AT)

Table 1 Summary Statistics
This table presents summary statistics for sample in high-tech industries (Panel A) and for the sample in low-tech industries (Panel B) covers period from 1980 to 2019.
All continuous variables are winsorized at the 1% and 99% levels. Variable definitions are provided in the Appendix.

Panel A			**High-Tech**			
Variable	Observations	Mean	Std. Dev.	Q25	Median	Q75
log(pat)$_{t+1}$	19,180	2.6314	1.6212	1.3863	2.1972	3.5553
log(pat)$_{t+1, t+3}$	14,922	4.0155	1.6456	2.7726	3.6636	4.9972
log(pat)$_{t+1, t+5}$	11,987	4.7569	1.6381	3.4965	4.4188	5.7807
log(adj.cit)$_{t+1}$	19,180	2.3870	1.7658	0.9776	2.0754	3.4782
log(adj.cit)$_{t+1, t+3}$	14,922	3.7565	1.8323	2.4249	3.5315	4.9324
log(adj.cit)$_{t+1, t+5}$	11,987	4.5051	1.8142	3.2066	4.2742	5.6862
Adj.NI $_{t+1}$	36,851	0.1222	0.2426	0.0516	0.1449	0.2359
Adj.NI $_{t+1, t+3}$	31,881	0.4536	0.7924	0.1902	0.4732	0.7831
Adj.NI $_{t+1, t+5}$	26,777	0.9291	1.4825	0.3813	0.8670	1.4687
RDEXP $_{t+1, t+5}$	36,871	0.7395	1.0890	0.1399	0.3653	0.8198
RDEXP	36,851	0.1213	0.1584	0.0281	0.0681	0.1394
CAPX	36,851	0.0466	0.0461	0.0165	0.0335	0.0612
MTB	36,850	3.4216	5.1077	1.3496	2.3091	4.0530
LEV	36,851	0.1731	0.1898	0.0074	0.1235	0.2715
CHE	36,851	0.2796	0.2613	0.0637	0.1926	0.4324
SIZE	36,851	5.3037	2.2193	3.6947	5.0319	6.7694
SGA	36,851	0.1798	0.2719	0.0910	0.1809	0.2947
AD	36,851	0.0088	0.0258	0.0000	0.0000	0.0050
M&A	36,851	0.0195	0.0713	0.0000	0.0000	0.0000
Adj.NI	36,851	0.0956	0.2249	0.0493	0.1329	0.2073
ΔAdj.NI	36,851	0.0151	0.1710	-0.0271	0.0170	0.0620
BM	36,851	0.5206	0.4839	0.2249	0.4131	0.7006
DVT	36,851	0.0100	0.0234	0.0000	0.0000	0.0115
RDEXP$_{t-1}$	36,851	0.1278	0.1746	0.0282	0.0685	0.1437
MB	36,871	2.5142	2.1307	1.2416	1.7807	2.8964
CHE$_{t-1}$	36,851	0.2774	0.2636	0.0604	0.1867	0.4289
FINCF	36,851	0.0894	0.2565	-0.0273	0.0000	0.0789
CFO	36,851	0.1001	0.1691	0.0358	0.1089	0.1861
ΔSALE	36,851	0.0768	0.2289	-0.0120	0.0652	0.1734
TSTK	36,851	0.0401	0.1143	0.0000	0.0000	0.0136
AQC	36,851	0.0181	0.0533	0.0000	0.0000	0.0023

Panel B			Low-Tech			
Variable	Observations	Mean	Std. Dev.	Q25	Median	Q75
$\log(pat)_{t+1}$	6,492	2.5594	1.6732	1.3863	2.0794	3.4965
$\log(pat)_{t+1,\ t+3}$	4,894	3.9784	1.7191	2.7081	3.6109	4.9628
$\log(pat)_{t+1,\ t+5}$	3,869	4.7425	1.7127	3.4340	4.4188	5.6904
$\log(adj.cit)_{t+1}$	6,492	2.3409	1.8231	0.9002	1.9909	3.3778
$\log(adj.cit)_{t+1,\ t+3}$	4,894	3.7389	1.9148	2.3487	3.4957	4.8825
$\log(adj.cit)_{t+1,\ t+5}$	3,869	4.5006	1.8989	3.1220	4.2421	5.6660
$Adj.NI_{t+1}$	18,686	0.1448	0.2135	0.0711	0.1434	0.2381
$Adj.NI_{t+1,\ t+3}$	15,330	0.5338	0.6999	0.2345	0.4616	0.7843
$Adj.NI_{t+1,\ t+5}$	12,281	1.0618	1.3623	0.4332	0.8361	1.4579
$RDEXP_{t+1,\ t+5}$	18,677	0.4269	0.7190	0.0440	0.1560	0.5087
RDEXP	18,686	0.0720	0.0999	0.0098	0.0337	0.1002
CAPX	18,686	0.0505	0.0463	0.0189	0.0375	0.0682
MTB	18,686	3.5778	5.2909	1.2908	2.2533	4.1412
LEV	18,686	0.1713	0.1812	0.0040	0.1299	0.2786
CHE	18,686	0.2371	0.2319	0.0480	0.1486	0.3797
SIZE	18,686	5.8039	2.2819	4.1112	5.5286	7.3753
SGA	18,686	0.2468	0.2260	0.1019	0.2060	0.3384
AD	18,686	0.0164	0.0376	0.0000	0.0000	0.0133
M&A	18,686	0.0244	0.0792	0.0000	0.0000	0.0000
Adj.NI	18,686	0.1135	0.2069	0.0675	0.1316	0.2068
ΔAdj.NI	18,686	0.0176	0.1653	-0.0194	0.0166	0.0592
BM	18,686	0.5664	0.5407	0.2264	0.4350	0.7570
DVT	18,686	0.0131	0.0270	0.0000	0.0000	0.0175
$RDEXP_{t-1}$	18,686	0.0785	0.1172	0.0098	0.0341	0.1051
MB	18,677	2.3879	2.0649	1.1922	1.6819	2.7125
CHE_{t-1}	18,684	0.2338	0.2311	0.0462	0.1445	0.3741
FINCF	18,686	0.0455	0.2044	-0.0396	0.0000	0.0398
CFO	18,686	0.1161	0.1537	0.0389	0.1131	0.1949
ΔSALE	18,686	0.0823	0.2230	-0.0074	0.0752	0.1793
TSTK	18,686	0.0494	0.1238	0.0000	0.0000	0.0279
AQC	18,686	0.0240	0.0578	0.0000	0.0000	0.0153

Table 2 The effect of R&D expenses and capital expenditure on corporate innovation

This table presents the results of the effect of R&D expenses and capital expenditure on patent and citation counts. Column (1) to (3) report the estimate from Eq(1). Column (4) to (6) report the estimate from Eq(2). The dependent variables in Panel A are the aggregated number of patents applied for during the year t+1 to t+i. . The dependent variables in Panel B are the aggregated adjusted number of citations to all the patents applied for during the year t+1 to t+i. HighTech is an indicator variable equal to one if the firm is in high-tech industry and zero otherwise. Variable Definitions are provided in the Appendix. Regressions include year and industry fixed effects. Standard errors are clustered at the firm level.

t-statistics are reported in parentheses. (*, **, and *** denote significance at the 10%, 5% and 1% level, respectively.

Panel A	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	$\log(pat)_{t+1}$	$\log(pat)_{t+1,\ t+3}$	$\log(pat)_{t+1,\ t+5}$	$\log(pat)_{t+1}$	$\log(pat)_{t+1,\ t+3}$	$\log(pat)_{t+1,\ t+5}$
RDEXP	2.508***	2.767***	2.864***	3.547***	3.926***	3.878***
	(16.579)	(14.683)	(12.752)	(6.671)	(5.032)	(3.471)
HighTech×RDEXP				-1.129**	-1.242	-1.073
				(-1.989)	(-1.515)	(-0.929)
CAPX	1.754***	2.152***	2.289***	0.218	0.357	0.014
	(4.129)	(4.406)	(4.313)	(0.291)	(0.383)	(0.014)
HighTech×CAPX				1.949**	2.224**	2.804**
				(2.234)	(2.114)	(2.419)
MTB	0.013***	0.014***	0.016***	0.012***	0.014***	0.015***
	(5.027)	(4.588)	(4.223)	(4.917)	(4.459)	(4.154)
LEV	-0.521***	-0.569***	-0.547***	-0.517***	-0.565***	-0.549***
	(-5.071)	(-4.773)	(-4.099)	(-5.050)	(-4.761)	(-4.120)
CHE	0.530***	0.702***	0.839***	0.552***	0.725***	0.862***
	(6.236)	(6.883)	(7.217)	(6.397)	(7.001)	(7.316)
SIZE	0.679***	0.736***	0.755***	0.679***	0.736***	0.755***
	(36.497)	(36.390)	(35.135)	(36.486)	(36.387)	(35.132)
Constant	-2.196***	-1.438***	-0.968***	-2.205***	-1.448***	-0.974***
	(-16.991)	(-9.592)	(-5.877)	(-17.106)	(-9.674)	(-5.917)
Observations	25,672	19,813	15,855	25,672	19,813	15,855
R-squared	0.577	0.621	0.644	0.578	0.622	0.645
Fiscal Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel B VARIABLES	(1) log(adj.cit)$_{t+1}$	(2) log(adj.cit)$_{t+1, t+3}$	(3) log(adj.cit)$_{t+1, t+5}$	(4) log(adj.cit)$_{t+1}$	(5) log(adj.cit)$_{t+1, t+3}$	(6) log(adj.cit)$_{t+1, t+5}$
RDEXP	2.514***	2.915***	3.079***	3.294***	3.979***	4.348***
	(13.585)	(11.992)	(10.654)	(5.248)	(4.235)	(3.367)
HighTech×RDEXP				-0.847	-1.138	-1.342
				(-1.278)	(-1.166)	(-1.010)
CAPX	2.934***	3.373***	3.517***	1.308	1.389	1.011
	(6.076)	(5.790)	(5.515)	(1.530)	(1.209)	(0.780)
HighTech×CAPX				2.074**	2.466*	3.086**
				(2.094)	(1.926)	(2.162)
MB	0.023***	0.027***	0.028***	0.022***	0.027***	0.028***
	(7.097)	(6.607)	(5.759)	(7.029)	(6.524)	(5.698)
LEV	-0.592***	-0.668***	-0.627***	-0.591***	-0.666***	-0.627***
	(-4.638)	(-4.210)	(-3.394)	(-4.643)	(-4.212)	(-3.397)
CHE	1.048***	1.240***	1.357***	1.068***	1.264***	1.384***
	(10.016)	(9.367)	(8.767)	(10.115)	(9.478)	(8.889)
SIZE	0.663***	0.722***	0.734***	0.663***	0.722***	0.735***
	(30.750)	(29.464)	(27.582)	(30.700)	(29.417)	(27.552)
Constant	-2.546***	-1.834***	-1.314***	-2.551***	-1.843***	-1.323***
	(-17.292)	(-10.184)	(-6.508)	(-17.320)	(-10.201)	(-6.530)
Observations	25,672	19,813	15,855	25,672	19,813	15,855
R-squared	0.446	0.476	0.497	0.447	0.477	0.499
Fiscal Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 3 The effect of R&D expenses and capital expenditure on future profitability
This table presents the results of the effect of R&D expenses and capital expenditure on futue profitability. The dependent variables is the aggregated adjusted net income during the year t+1 to t+i. Observations with missing net income for future years are dropped. HighTech is an indicator variable equal to one if the firm is in high-tech industry and zero otherwise.
Variable Definitions are provided in the Appendix. Regressions include year and industry fixed effects. Standard errors are clustered at the firm level.
t-statistics are reported in parentheses. (*, **, and *** denote significance at the 10%, 5% and 1% level, respectively.

VARIABLES	(1) $Adj.NI_{t+1}$	(2) $Adj.NI_{t+1, t+3}$	(3) $Adj.NI_{t+1, t+5}$
RDEXP	0.224***	0.893***	1.661***
	(4.509)	(3.586)	(2.895)
CAPX	0.153***	1.054***	2.107***
	(3.780)	(5.489)	(4.539)
RDEXP × CAPX	-0.695	-3.041	-3.571
	(-1.341)	(-1.300)	(-0.673)
HighTech × RDEXP	-0.267***	-1.047***	-1.932***
	(-4.876)	(-3.848)	(-3.093)
HighTech × CAPX	-0.050	-0.582**	-1.070*
	(-1.014)	(-2.503)	(-1.934)
HighTech × RDEXP × CAPX	0.953	6.564**	11.900*
	(1.578)	(2.375)	(1.952)
SGA	0.045***	0.224***	0.474***
	(6.702)	(6.533)	(5.701)
AD	0.450***	1.979***	3.865***
	(11.426)	(10.259)	(8.005)
M&A	0.014	0.012	0.063
	(1.490)	(0.295)	(0.629)
Adj.NI	0.745***	2.171***	3.563***
	(78.169)	(50.038)	(36.766)
ΔAdj.NI	-0.155***	-0.428***	-0.640***
	(-15.768)	(-11.367)	(-8.353)
BM	-0.047***	-0.145***	-0.304***
	(-22.887)	(-17.139)	(-15.226)
Constant	0.059***	0.219***	0.507***
	(19.350)	(15.494)	(15.584)
Observations	55,537	47,211	39,057
R-squared	0.506	0.428	0.344
Fiscal Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes

Table 4 Relation between aggregated R&D expenses and capital expenditures
This table presents the results of the relation between aggregated R&D expenses and capital expenditures. The dependent variables is the aggregated R&D expenses during the year t+1 to t+i. HighTech is an indicator variable equal to one if the firm is in high-tech industry and zero otherwise. Variable Definitions are provided in the Appendix. Regressions include year and industry fixed effects. Standard errors are clustered at the firm level.
t-statistics are reported in parentheses. (*, **, and *** denote significance at the 10%, 5% and 1% level, respectively.

VARIABLES	(1) $RDEXP_{t+1, t+5}$
CAPX	0.345**
	(2.033)
HighTech×CAPX	0.390*
	(1.790)
$RDEXP_{t-1}$	2.793***
	(35.597)
MB	0.111***
	(23.794)
LEV	0.142***
	(3.759)
CHE_{t-1}	0.419***
	(13.158)
SIZE	-0.057***
	(-14.577)
SGA	-0.267***
	(-6.081)
AD	0.178
	(0.867)
FINCF	-0.114***
	(-3.088)
CFOBRD	0.131**
	(2.281)
ΔSALE	0.007
	(0.317)
DVT	-0.438
	(-1.643)
TSTK	-0.088**
	(-2.534)
AQC	-0.259***
	(-4.969)
Constant	0.259***
	(8.125)
Observations	55,548
R-squared	0.519
Fiscal Year FE	Yes
Industry FE	Yes

Table 5 The declining effect of R&D expenses on future profitability
This table presents the results of the effect of R&D expenses and capital expenditure on future profitability. The dependent variables is the aggregated adjusted net income during the year t+1 to t+5. Variable Definitions are provided in the Appendix.
Standard errors in column (1) are clustered at the firm and fiscal year level. Regressions in column (2) to (4) include year and industry fixed effects and standard errors are clustered at the firm level. t-statistics are reported in parentheses. (*, **, and *** denote significance at the 10%, 5% and 1% level, respectively.

Panel A	(1)	(2)	(3)	(4)
	Replication	All	High-Tech	Low-Tech
VARIABLES	$Adj.NI_{t+1, t+5}$	$Adj.NI_{t+1, t+5}$	$Adj.NI_{t+1, t+5}$	$Adj.NI_{t+1, t+5}$
RDEXP	0.617***	0.277*	0.135	1.331***
	(2.877)	(1.675)	(0.752)	(2.649)
CAPX	2.352***	2.027***	1.771***	2.468***
	(8.747)	(8.380)	(6.051)	(5.796)
SGA	0.818***	0.538***	0.496***	0.480***
	(7.472)	(6.542)	(5.166)	(2.775)
AD	3.389***	3.907***	3.454***	4.464***
	(4.934)	(8.034)	(5.374)	(6.331)
M&A	0.109	0.102	0.100	0.033
	(0.738)	(1.020)	(0.803)	(0.196)
Adj.NI	3.584***	3.577***	3.726***	3.147***
	(17.576)	(36.675)	(32.882)	(17.010)
ΔAdj.NI	-0.631***	-0.654***	-0.836***	-0.215
	(-5.112)	(-8.556)	(-10.106)	(-1.361)
BM	-0.280***	-0.303***	-0.330***	-0.284***
	(-7.338)	(-15.215)	(-13.098)	(-8.792)
Constant	0.384***	0.470***	0.503***	0.435***
	(9.978)	(14.535)	(12.861)	(7.836)
Observations	34,270	39,057	26,777	12,280
R-squared	0.297	0.341	0.341	0.355
Fiscal Year FE	No	Yes	Yes	Yes
Industry FE	No	Yes	Yes	Yes

Panel B	(1)	(2)	(3)	(4)
	Replication	All Industries	High-Tech	Low-Tech
VARIABLES	$Adj.NI_{t+1, t+5}$	$Adj.NI_{t+1, t+5}$	$Adj.NI_{t+1, t+5}$	$Adj.NI_{t+1, t+5}$
RDEXP	2.828***	2.397***	2.443***	2.062*
	(5.906)	(5.775)	(5.347)	(1.812)
Trend × RDEXP	-0.101***	-0.087***	-0.095***	-0.036
	(-4.516)	(-5.228)	(-5.193)	(-0.722)
CAPX	0.996**	1.168***	1.436***	0.244
	(2.247)	(2.811)	(2.739)	(0.360)
Trend × CAPX	0.045	0.045*	0.016	0.127***
	(1.599)	(1.836)	(0.513)	(3.670)
SGA	0.865***	0.897***	1.221***	0.218
	(4.381)	(5.614)	(6.161)	(0.738)
Trend × SGA	-0.005	-0.016**	-0.031***	0.014
	(-0.467)	(-2.258)	(-3.654)	(0.917)
AD	4.246***	4.148***	4.732***	3.358**
	(3.098)	(4.476)	(3.948)	(2.306)
Trend × AD	-0.070	-0.017	-0.092	0.049
	(-1.063)	(-0.377)	(-1.504)	(0.788)
M&A	-0.344	-0.093	-0.329	0.349
	(-1.076)	(-0.370)	(-1.034)	(0.866)
Trend × M&A	0.023*	0.008	0.019	-0.014
	(1.737)	(0.868)	(1.632)	(-0.923)
Adj.NI	3.499***	3.208***	3.313***	3.599***
	(8.522)	(11.837)	(10.733)	(6.312)
Trend × Adj.NI	0.000	0.014	0.014	-0.021
	(0.018)	(1.217)	(1.088)	(-0.827)
Δadj.NI	-0.072	-0.127	-0.105	-0.835**
	(-0.254)	(-0.602)	(-0.431)	(-1.981)
Trend × Δadj.NI	-0.026**	-0.022**	-0.030***	0.028
	(-2.111)	(-2.489)	(-2.972)	(1.482)
BM	-0.468***	-0.453***	-0.542***	-0.378***
	(-9.017)	(-11.936)	(-10.667)	(-6.648)
Trend × BM	0.010***	0.008***	0.011***	0.005*
	(3.012)	(4.519)	(4.769)	(1.832)
Trendt	-0.009**			
	(-2.404)			
Constant	0.581***	0.454***	0.467***	0.437***
	(8.389)	(14.723)	(12.892)	(7.961)
Observations	34,270	39,057	26,777	12,280
R-squared	0.309	0.349	0.353	0.358
Fiscal Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes