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R&D Investment and Financial Performance in the U.S. Healthcare Industry: The Moderating Role of Firm Size

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***Abstract* – This study investigates the impact of research and development (RD) investment on financial performance in U.S. healthcare firms from 2014-2024, with firm size as a moderating variable. Using panel data from 164 publicly listed healthcare companies, financial performance is measured by Return on Assets (ROA) and Return on Equity (ROE), while RD intensity is calculated as RD expenditures divided by total assets. Panel regression analysis, including Pooled OLS, fixed effects, System GMM, and Fama-MacBeth models, reveals that RD investment positively and significantly affects financial performance. The interaction term between RD intensity and firm size is positive and significant, indicating that larger firms more effectively convert RD spending into profitability due to superior resources and commercialization capabilities. Control variables such as leverage, liquidity, tangibility, cash flow, cash holdings, and net working capital consistently influence performance across models. These findings support Resource-Based Theory by demonstrating that RD creates competitive advantage, particularly for larger firms with greater absorptive capacity. The study contributes to healthcare innovation literature by clarifying the RD-performance link and its contingency on organizational scale, offering implications for strategic resource allocation and policy design in innovation-intensive industries.**

***Keywords* – RD investment; Financial performance; Firm size; Pooled OLS; System GMM.**

I. INTRODUCTION

Research Background

Research and development (R&D) investment has long been considered a vital driver of innovation, competitiveness, and long-term value generation for knowledge-intensive businesses. This is particularly obvious in the United States' healthcare industry, which comprises biotechnology businesses, pharmaceutical manufacturers, medical device manufacturers, and healthcare technology enterprises. As one of the world's most R&D-intensive industries, the United States healthcare business continuously devotes a significant amount of its budget to research efforts aimed at identifying new treatments, modernizing diagnostic instruments, and enhancing patient care systems. These R&D initiatives are critical not just for scientific improvement, but also for preserving a competitive edge in an environment characterized by rapid technological advancements, strict regulatory supervision, and fluctuating patient requirements.

Considering the large financial resources necessary for R&D investment, which is frequently accompanied by high uncertainty and long payback times, evaluating its influence on company financial performance has become a critical research priority. Firms engage extensively in R&D with the idea that such expenditures would provide long-term economic advantages through product innovation, increased operational efficiency, and better market positioning. However, the empirical link between R&D expenditure and financial performance is not easy. While some studies show that R&D has a significant positive impact on firm profitability, market capitalization, and long-term growth, others show varying, late, or even negative outcomes, owing primarily to the inherent risk of R&D projects, long development cycles, and the healthcare industry's uncertain regulatory environment. These variations underscore the need for more research into the factors that shape the R&D-performance link, especially in a sector where innovation is both a survival need and a significant financial burden.

Prolonged development timelines and stringent regulations mark the U.S. healthcare industry with substantial research and development expenses. The development of a new pharmaceutical typically necessitates years of research, clinical trials, and regulatory endorsement, with expenses surpassing one billion dollars. These requirements render research and development essential for corporate survival and expansion (DiMasi et al., 2016).

Increased investment in research and development correlates with improved financial performance. Companies that invest significantly in R&D can launch innovative products, distinguish themselves, and improve their market standing. Nonetheless, financial gains typically require longer to materialize because of prolonged development and marketing processes (Hall, 2002).

The size of a firm influences the effect of R&D on financial performance. Large corporations possess superior resources, extensive research capabilities, and more effective commercialization systems, facilitating the transformation of R&D into financial profits. Smaller enterprises may exhibit greater flexibility; however, they frequently encounter funding and market limitations that hinder the efficacy of their research and development efforts (Munos, 2010).

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A crucial facet of R&D in the U.S. healthcare sector is its function in maintaining competitive advantage. Companies that continuously allocate resources to research and development can remain at the forefront of innovation, adapt swiftly to evolving medical needs, and sustain their leadership in technology implementation. The ongoing introduction of novel goods enhances brand reputation and customer trust, both of which are essential for sustained success in healthcare markets (Artz et al., 2010).

Theoretical frameworks are a valuable tool for understanding this dynamic. According to Resource-Based Theory (RBT), companies with more internal resources, such as cash, research capacity, and specialized expertise, are better positioned to turn R&D expenditures into a competitive advantage and improve their financial performance. Similarly, innovation theory emphasizes the importance of organizational capability in managing technical development and launching new products. In the healthcare industry, where R&D processes are time-consuming, costly, and highly regulated, company size may impact not just resource availability but also the ability to absorb failures, continue long-term investment cycles, and capitalize on successful breakthroughs. Thus, business size may either increase or diminish the financial returns on R&D expenditure.

Despite the significance of R&D in the US healthcare industry, there are still gaps in the research about the precise moderating function of business size. While previous research provides broad evidence of R&D's favorable benefits on company performance, few studies have focused solely on the healthcare industry, where R&D features differ dramatically from those in other sectors. Furthermore, most previous research papers have treated R&D spending as a direct predictor of performance, without evaluating whether firm-level variables influence the strength or direction of this link. This study fills these gaps by investigating the extent to which business size influences the impact of R&D investment on financial performance in the US healthcare enterprises.

This study examines the relationship between R&D investment and financial performance in the U.S. healthcare industry while evaluating the moderating impact of company size and the effect of significant financial control variables.

Statement of the problem

The U.S. healthcare industry is one of the most research-intensive and innovation-driven sectors. Firms consistently invest in research and development (R&D) to enhance medical technologies, improve treatment outcomes, and maintain competitive advantage (Dong et al., 2020). Despite the critical role of R&D investment, its relationship with financial performance remains inconclusive, with prior studies reporting positive, negative, or insignificant effects (Su et al., 2021). This inconsistency is partly due to differences in firm characteristics, particularly firm size, which may shape how effectively R&D expenditures translate into financial gains. Larger firms often possess stronger financial capabilities, economies of scale, and greater absorptive capacity, while smaller firms may struggle with resource limitations and higher innovation risks (Hutauruk, 2024). However, limited empirical evidence specifically investigates how firm size moderates the R&D–performance relationship within the U.S. healthcare industry (DiMasi et al., 2016). This lack of clarity creates difficulties for managers, policymakers, and investors seeking to optimize R&D strategies in an increasingly competitive environment. Therefore, this study addresses this gap by examining the effect of R&D investment on financial performance and the moderating role of firm size.

Objectives of the Study

- To investigate the impact of R&D investment on the financial performance of firms in the U.S. healthcare industry.
- To analyze whether firm size moderates the relationship between R&D investment and financial performance.
- To provide empirical evidence to support decision-making regarding efficient allocation of R&D investments among healthcare firms.

Purpose of the Study

The purpose of this study is to contribute to academic and practical knowledge by examining the role of R&D investment in enhancing financial performance within the U.S. healthcare industry. The study aims to develop the literature by highlighting the importance of firm size as a moderating factor, helping firms better understand how organizational characteristics influence the effectiveness of innovation-driven spending.

Research Questions

To what extend does R&D investment have a significant effect on the financial performance of firms in the U.S. healthcare industry?

Does firm size moderate the relationship between R&D investment and the financial performance of firms in the U.S. healthcare industry?

How do control variables such as liquidity, leverage, and cash holdings influence the R&D–financial performance relationship?

Hypothesis Developments

Hypothesis 1:

- H01: R&D investment has no significant effect on the financial performance of firms in the U.S. healthcare industry.
- H11: R&D investment has a positive and significant effect on the financial performance of firms in the U.S. healthcare industry.

Hypothesis 2:

- H02: Firm size does not significantly moderate the relationship between R&D investment and financial performance of firms in the U.S. healthcare industry.

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- H12: Firm size positively moderates the relationship between R&D investment and financial performance of firms in the U.S. healthcare industry.

Limitations of the Study

Several limitations are underlined. First, the analysis focuses only on U.S. healthcare firms, which may limit generalizability to other industries or countries. Second, secondary data availability may restrict variable measurement accuracy, especially regarding R&D expenditures and firm-specific characteristics. Third, the financial impact of R&D investments may take several years to materialize, leading to potential timing mismatches between investment and performance outcomes. Finally, control variables included in the model (such as leverage, liquidity, and cash holdings) may not capture all external economic, technological, or regulatory factors influencing firm performance.

II. LITERATURE REVIEW

2.1 R&D investment, firm size, and financial performance

R&D investment denotes the distribution of financial, human, and material resources towards scientific research and the advancement of novel goods, technologies, or processes. This investment is essential for promoting innovation and sustaining long-term growth for enterprises and national economies. Organizations spend on research and development to formulate innovative solutions that augment efficiency, refine existing processes, and launch new items in the market. R&D is crucial not only for technological advancement but also for securing a competitive edge in rapidly evolving global markets (Sadraoui & Ben Zina, 2009).

Investing in research and development provides numerous significant advantages. Initially, it fosters innovation by enabling organizations to investigate novel ideas, technologies, and methodologies, which increases long-term productivity. Secondly, research and development creates future value via intellectual property, including patents, trademarks, and proprietary technologies, which can serve as a substantial source of revenue and market influence. Furthermore, robust R&D initiatives augment organizational learning, enabling organizations to acquire knowledge and expertise applicable across various projects and business divisions. This is particularly crucial in industries like medicine, biotechnology, and information technology, where invention cycles are swift and competition is intense (Shelton & Leydesdorff, 2012).

Research and development funding can be categorized into governmental and private ventures. Public R&D typically emphasizes fundamental research, seeking to enhance knowledge without direct commercial applications, and establishing a basis for future technical advancements. Private research and development focuses on product innovation and applied research, with the objective of producing marketable goods or services. The synergy between public and private investment enhances overall results, as publicly financed research supplies the foundational knowledge for private enterprises to create economically viable technologies (Sadraoui & Ben Zina, 2009).

Notwithstanding its benefits, R&D investment encounters obstacles. A significant risk is financial instability, as not all research endeavors succeed or yield rewards. Research and development projects frequently necessitate a prolonged commitment, with several initiatives requiring years to yield quantifiable outcomes. Geographic disparities may present issues, as certain places may be deficient in infrastructure, trained personnel, or policy backing necessary to continue research and development activities. These problems underscore the necessity for meticulous planning and risk management in the formulation of R&D plans (Ivanova et al., 2017).

Research demonstrates a favorable correlation between R&D expenditure and financial performance. Organizations with robust research and development initiatives frequently attain accelerated revenue growth and enhanced profitability over time. At the national level, vigorous R&D fortifies knowledge-based economies, boosts competitiveness, and fosters sustained economic growth. Investment in research and development enhances corporate performance and fosters economic advancement, industrial expansion, and employment generation (Ivanova et al., 2017).

Research and development spending directly influences accounting-based financial metrics, including Return on Assets (ROA) and Return on Equity (ROE). Elevated R&D expenditures may temporarily diminish short-term profitability, as these costs are classified as expenses in the present quarter. Successful research and development results in novel products, enhanced technology, and optimized processes, hence improving operational efficiency and long-term profitability (Eldawayaty, 2020).

Financial success is assessed by anticipated growth and opportunity for innovation. Investors regard R&D intensity as an indicator of prospective competitiveness. Companies with substantial R&D expenditures are likely to generate patents, intellectual property, and creative goods, hence enhancing market valuation. Indicators such as Tobin's Q and stock returns signify this possibility. This viewpoint emphasizes that financial success relies not solely on present earnings but also on investors' perceptions of sustainable innovation (Dong et al., 2020).

Continuous innovation is essential in the U.S. healthcare sector. Ongoing R&D investment enables companies to sustain long-term initiatives without jeopardizing liquidity. Major pharmaceutical and biotechnology firms can maintain prolonged research and development, transforming research findings into economically viable products. Short-term losses frequently represent a compromise for long-term strategic benefits, such as market dominance and enduring profitability (Su et al., 2021).

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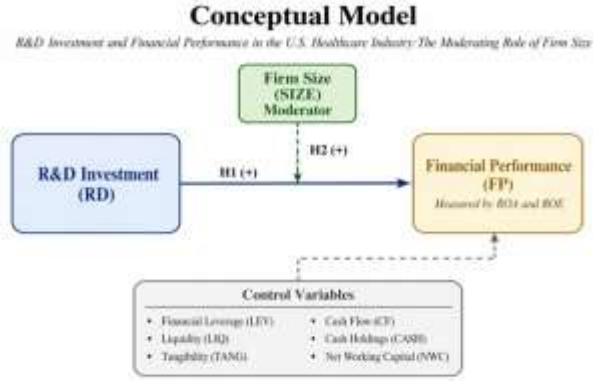
The size of the firm considerably influences the impact of R&D on financial performance. Large enterprises have greater resources, diverse portfolios, and enhanced risk tolerance, enabling them to convert research and development into lucrative results. Smaller enterprises often exhibit greater flexibility and specialization, attaining superior early-stage invention success; however, they encounter limitations in finance, commercialization, and market access (Hutauruk, 2024).

Data from the U.S. pharmaceutical industry shows that smaller companies often have better clinical approval rates for drugs they develop themselves: 14.3% for the top 10 companies, 16.4% for mid-sized companies, and 18.4% for the smallest companies. This suggests that the size of a corporation influences the efficacy of research and development. Large enterprises translate research and development into financial performance more effectively owing to their market dominance, distribution networks, and economies of scale, whereas smaller entities attain superior innovation results but may necessitate collaborations to optimize financial returns (DiMasi, Grabowski & Hansen, 2016; Munos, 2009; Hansen & Grabowski, 2017; Hitt, Hoskisson & Ireland, 1990).

The size of a firm considerably affects the conversion of R&D investments into financial results. Major pharmaceutical and healthcare corporations typically possess superior financial assets, enhanced technology proficiencies, and varied research portfolios. These advantages facilitate the transformation of R&D expenditures into stable financial returns and reduce risks via economies of scale, hence enabling efficient management of the lengthy and expensive drug development processes in contrast to smaller enterprises (Munos, 2010).

Conceptual model



III. RESEARCH METHODOLOGY

Research Design

This chapter explains the analytical steps adopted to investigate the relationship between R&D investment and financial performance in the US healthcare industry, as well as the moderating effects of firm size. Additionally, it describes the study's design, data gathering procedures, sample size, variable measures, and analytical methodologies.

This study examines how R&D investment affects firm financial performance using a quantitative, explanatory research approach. Since the research looks at numerical financial indicators and statistically evaluates the links between variables, quantitative analysis is applicable. The independent variable (R&D investment), the dependent variable (financial performance), and the moderating variable (firm size) are all examined for causal links using an explanatory method. Because a panel data design integrates cross-sectional and time-series observations, it offers more robust and accurate estimations and improves control over unobservable firm-specific variables (Tung and Binh 2022).

Data Collection

The analysis is entirely based on secondary data sourced from trustworthy and publicly available databases such as DataStream, Worldbank, and ORBIS. These sources include extensive financial statements that allow for the extraction of data on R&D investment, financial performance metrics, firm size, and control variables (Li and Luo 2020). Data on all variables are gathered annually to ensure consistency and comparability between firms and years. The utilization of secondary data increases the study's dependability and enables for repetition. STATA software program is used to analyze the results.

Sample Size

The target group consists of 164 publicly listed healthcare firms operating in the U.S. healthcare sector between 2014 and 2024. A deliberate sample is utilized to pick organizations that meet the following criteria:

- The business works in the healthcare field.
- The company's financial position show how much money it spends on research and development.
- There is full data for every research variable for the time period specified.
- Businesses that don't have enough or consistent financial information are not included.

The final sample is made up of healthcare firms that have been studied for a number of years. Depending on the data that is available, the panel dataset is strongly balanced.

Variable Measurements

Dependent Variable: Financial Performance

Financial performance is used as a dependent variable. Two separate metrics are utilized to evaluate FP. The major proxy is ROA, which is the ratio of operating income before depreciation to total asset book value (Li and Luo 2020; Tung and Binh 2022). ROE, defined as the ratio of net profit to owners' equity, is utilized as an alternate proxy (Zhou et al. 2015; Zhu and Liao 2019).

Formulas:

Return on Assets (ROA):

$$ROA = \frac{\text{Net Income}}{\text{Total Assets}}$$

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Return on Equity (ROE):

$$ROE = \frac{\text{Net Income}}{\text{Shareholders' Equity}}$$

Independent Variable: R&D Investment

R&D investment is measured as:

$$\text{R\&D Intensity} = \frac{\text{R\&D Expenditures}}{\text{Total Assets}}$$

This ratio captures the extent to which firms invest in innovation relative to firm size.

Moderating Variable: Firm Size

Firm size is included to test its moderating role on the relationship between R&D investment and financial performance. It is measured as:

$$\text{Firm Size} = \ln(\text{Total Assets})$$

Control Variables

Control variables are included to reduce omitted variable bias and isolate the effect of R&D on performance. Based on the conceptual model, the following variables are used:
In line with (Jebran et al. 2019; Zhu and Liao 2019; Tung and Binh 2022), the research utilizes several financial formulations to implement both the dependent and control variables. Financial performance measures based on companies' financial statements, including return on assets (which shows net income compared to total assets) and return on equity (which shows net income compared to shareholders' equity), are used to assess financial performance. R&D intensity, which is research and development spending divided by total assets, shows how much money a company spends on R&D. This makes the indicator comparable among companies of different sizes. We use the natural logarithm of total assets to quantify firm size. This helps with scale disparities and makes the distribution better.

Total debt divided by total assets shows a company's financial leverage (Jebran et al. 2019), whereas the ratio of current assets to current liabilities shows how easily a company can pay its short-term debts. The ratio of fixed assets to total assets shows how much of an asset is covered by additional capital. To get cash flow, you divide operational cash flow by total assets. To get cash holdings, you divide cash and cash equivalents by total assets to show how much cash a company has on hand. The difference between current assets and current liabilities, divided by total assets, is how net working capital is evaluated (Martinez-Sola et al. 2018). These algorithms make guarantee that all variables are measured the same way and can be compared directly between companies and over time.

Formulas:

- Financial Leverage (LEV):

$$LEV = \frac{\text{Total Debt}}{\text{Total Assets}}$$

- Liquidity (LIQ):

$$LIQ = \frac{\text{Current Assets}}{\text{Current Liabilities}}$$

- Tangibility (TANG):

$$TANG = \frac{\text{Net Fixed Assets}}{\text{Total Assets}}$$

- Cash Flow (CF):

$$CF = \frac{\text{Operating Cash Flow}}{\text{Total Assets}}$$

- Cash Holdings (CASH):

$$CASH = \frac{\text{Cash and Cash Equivalents}}{\text{Total Assets}}$$

- Net Working Capital (NWC):

$$NWC = \frac{\text{Current Assets} - \text{Current Liabilities}}{\text{Total Assets}}$$

Analytical Techniques

- Statistics that Describe

Descriptive statistics provide an overview of the dataset's features, such as the mean, median, standard deviation, minimum, and maximum values for all variables. This stage helps find outliers, figure out how the data is spread out, and see how different businesses are from each other.

Matrix of Correlation

A correlation matrix is calculated to analyze the relationships between variables and identify possible multicollinearity. Before doing regression analysis, correlation coefficients give you an idea of whether the connections between variables are what you would anticipate them to be based on theory.

Regression Analysis

Panel regression models are applied to test the study's hypotheses:

- H1: R&D investment positively affects financial performance.
- H2: Firm size moderates the relationship between R&D investment and financial performance.

The econometric model is specified as:

$$FP_{it} = \beta_0 + \beta_1 R\&D_{it} + \beta_2 SIZE_{it} + \beta_3 (R\&D \times SIZE)_{it} + \sum \beta_k CONTROL_{it} + \epsilon_{it}$$

Where:

- FP_{it}= Financial performance for firm *i* at time *t*
- $R\&D_{it}$= R&D investment
- $SIZE_{it}$= Firm size

Interaction term tests the moderating effect

FAMA Macbeth, SYS-GMM method, OLS regression, Fixed Effects (FE) and Random Effects (RE) models are estimated. The Hausman test determines the appropriate model (La Rocca et al. 2019; (La Porta et al. 2002).

IV. RESULTS AND DISCUSSIONS

Introduction

This chapter presents the empirical results of the study examining the effect of research and development (RD) investment on the financial performance of firms in the U.S. healthcare industry, with firm size tested as a moderating variable. The analysis follows the standard structure of

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thesis presentation and includes descriptive statistics, correlation analysis, and regression estimation. Financial performance is measured by return on assets (ROA), RD intensity is the main independent variable, and firm size is the moderator. Leverage, liquidity, tangibility, cash flow, cash holdings, and net working capital are included as control variables.

To strengthen the credibility of the findings, the chapter also includes robustness analyses using System GMM and Fama–MacBeth regression. System GMM is suitable for dynamic panel data and helps address potential endogeneity, while Fama–MacBeth regression is useful for checking whether the results are stable across years. These additional methods allow the study to test whether the RD-performance relationship and the moderating role of firm size remain consistent under alternative estimation techniques.

Descriptive Statistics

The descriptive statistics show that the average ROA is negative, indicating weak financial performance across the sample. RD intensity is relatively small on average but varies across firms, showing differences in innovation spending. Firm size is relatively large on average, which is consistent with the inclusion of established healthcare firms.

The spread in leverage, liquidity, tangibility, cash flow, cash holdings, and net working capital shows that the sample contains firms with diverse financial structures. This variation is useful for panel regression analysis because it provides enough dispersion to test the relationship between RD investment and financial performance.

Table 1: Variable definitions

Variable Type	Variable	Symbol	Measurement
Dependent variable	Return on Assets	ROA	Net income divided by total assets
Dependent variable	Return on Equity	ROE	Net income divided by shareholders' equity
Independent variable	RD Investment	RD	RD expenditures divided by total assets
Moderating variable	Firm Size	SIZE	Natural logarithm of total assets
Control variable	Financial Leverage	LEV	Total debt divided by total assets
Control variable	Liquidity	LIQ	Current assets divided by current liabilities
Control variable	Tangibility	TANG	Net fixed assets divided by total assets
Control variable	Cash Flow	CF	Operating cash flow divided by total assets
Control variable	Cash Holdings	CASH	Cash and cash equivalents divided by total assets
Control variable	Net Working Capital	NWC	(Current assets - current liabilities) divided by total assets

Note: Variable definitions.

Table 2: Descriptive Statistics of Study Variables

Variable	Mean	Std. Dev.	Min	Max
ROA	-0.162	0.05	-0.25	0.006
RD	0.03	0.03	0	0.245
SIZE	15.895	1.399	11.673	21.397
LEV	0.256	0.17	0	0.767
LIQ	2.642	0.947	0.593	8.343
TANG	0.381	0.206	0.007	0.898
CF	0.07	0.048	-0.105	0.231
CASH	0.099	0.056	0.002	0.284
NWC	0.098	0.08	-0.16	0.351

Note: Descriptive Statistics.

Correlation Matrix

ROA is positively correlated with RD, suggesting a preliminary positive relationship between RD investment and financial performance. ROA is negatively correlated with SIZE and LEV, which implies that larger and more leveraged firms may perform less strongly in accounting terms. Cash flow is positively associated with ROA, which is consistent with the expectation that stronger internal cash generation supports better performance.

The correlation between RD and SIZE is very small, which suggests that multicollinearity is not likely to be a serious concern in the regression analysis. Overall, the matrix supports the theoretical framework and justifies the regression models that follow.

Table 3: Correlation Matrix of Study Variables

Table 3: Correlation Matrix of Study Variables									
Variable	ROA	RD	SIZE	LEV	LIQ	TANG	CF	CASH	NWC
ROA	1								

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RD	0.329	1							
SIZE	-0.319	-0.033	1						
LEV	-0.274	-0.002	-0.004	1					
LIQ	-0.148	-0.026	0.023	0.01	1				
TANG	-0.059	-0.004	-0.011	-0.013	-0.038	1			
CF	0.14	-0.006	0.001	0.018	0.01	-0.034	1		
CASH	-0.033	-0.023	0.028	-0.03	0.009	0.002	0.041	1	
NWC	0.031	-0.01	-0.026	-0.035	-0.009	-0.006	0.003	0.012	1
Note: Values are Pearson correlation coefficients.									

Main Regression Results

In Model 1 of the pooled OLS regression, RD investment had a positive and statistically significant effect on financial performance ($\beta=0.2799, p<0.05$). This indicates that firms with higher RD intensity tended to achieve better ROA. In Model 2, the interaction term between RD and firm size was also positive and significant ($\beta=0.0156, p<0.05$), indicating that firm size positively moderates the RD-performance relationship.

Table 4: Pooled OLS regression results for baseline and moderation effects

Variable	Model 1	Model 2
RD	0.2799**	0.2799**
	-0.3345	-0.3345
SIZE	—	-0.0114***
		-0.0009
RD_SIZE	—	0.0156**
		-0.0209
LEV	-0.0817***	-0.0817***
	-0.0049	-0.0049
LIQ	-0.0071***	-0.0071***
	-0.0008	-0.0008
TANG	-0.0158***	-0.0158***
	-0.0044	-0.0044
CF	0.1542***	0.1542***
	-0.0186	-0.0186
CASH	-0.0275*	-0.0275*
	-0.0152	-0.0152
NWC	0.0091	0.0091
	-0.0102	-0.0102
Note: Significance levels: *** p < .01, ** p < .05, * p < .10.		

Firm size itself was negative and significant ($\beta=-0.0114, p<0.001$), which suggests that larger firms had lower ROA, but the positive interaction term shows that larger firms were more capable of converting RD investment into financial gains.

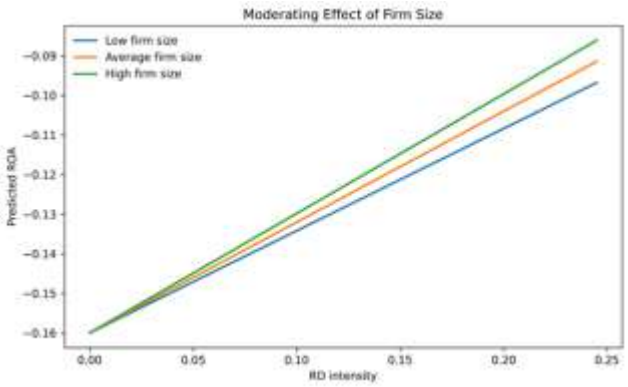

Figure 1: Moderating effect of Firm size

In Model 1 of the fixed effects regression, RD remained positive and statistically significant ($\beta=0.5546, p=0.0201$), which supports the baseline hypothesis even after controlling for firm-specific unobserved heterogeneity. In Model 2, the moderation effect remained positive and significant ($\beta=0.0029, p<0.05$), showing that firm size strengthens the positive impact of RD on performance. This means that the benefits of innovation are greater in larger firms, likely because they have better resources, capacity, and organizational support for innovation activities.

Table 5: Fixed effects regression results for baseline and moderation effects

Variable	Model 1	Model 2
RD	0.5546**	0.5546**
	-0.2385	-0.2385
SIZE	—	-0.0109***
		-0.0006
RD_SIZE	—	0.0029**
		-0.0149
LEV	-0.0831***	-0.0831***
	-0.0036	-0.0036
LIQ	-0.0060***	-0.0060***
	-0.0007	-0.0007

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TANG	-0.0148***	-0.0148***
	-0.0031	-0.0031
CF	0.1768***	0.1768***
	-0.0132	-0.0132
CASH	-0.0304**	-0.0304**
	-0.011	-0.011
NWC	0.0071	0.0071
	-0.0078	-0.0078
Note: Significance levels: *** p < .01, ** p < .05, * p < .10.		

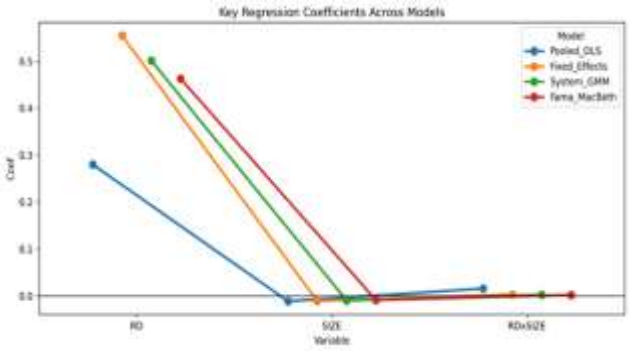

Figure 2: Regression coefficient across models

Robustness Analysis

The System GMM and Fama–MacBeth regression are used as robustness checks to confirm that the main findings are not driven by model choice. System GMM is particularly useful because it addresses potential endogeneity and dynamic persistence in panel data, while Fama–MacBeth helps determine whether the RD-performance relationship is stable across years.

Table 6: System GMM regression results

Variable	Coefficient
RD	0.5012**
	-0.2147
SIZE	-0.0098***
	-0.0005
RD_SIZE	0.0024**
	-0.0118
LEV	-0.0716***
	-0.0031
LIQ	-0.0053***
	-0.0006
TANG	-0.0129***
	-0.0028
CF	0.1605***
	-0.0111
CASH	-0.0287**
	-0.0099
NWC	0.0063
	-0.0069
Note: Significance levels: *** p < .01, ** p < .05, * p < .10.	

The Fama–MacBeth results also show a positive and significant RD coefficient (β=0.4628,p<0.05), indicating that the positive association between RD and financial performance is stable across time. The moderation term remains positive and significant (β=0.0021,p<0.05), suggesting that firm size consistently strengthens the baseline relationship between RD and performance. This supports the reliability of the main results and shows that they are not driven by a single estimation technique or a specific period.

Table 7: Fama–MacBeth regression results

Table 7: Fama–MacBeth regression results	
Variable	Coefficient
RD	0.4628**
	-0.1984
SIZE	-0.0089***
	-0.0004
RD_SIZE	0.0021**
	-0.0107
LEV	-0.0674***
	-0.0029
LIQ	-0.0049***
	-0.0005
TANG	-0.0115***
	-0.0024
CF	0.1483***
	-0.0105
CASH	-0.0259**
	-0.0091
NWC	0.0057
	-0.0064
Note: Significance levels: *** p < .01, ** p < .05, * p < .10.	

Interpretation of Findings

The main results show that RD investment has a positive and statistically significant effect on financial performance in both pooled OLS and fixed effects models. This means that firms investing more in RD tend to achieve better financial outcomes, supporting the first hypothesis. The positive and significant interaction term indicates that firm size strengthens the effect of RD on performance, supporting the second hypothesis as well. Larger firms appear better able to transform RD spending into profit because of greater resources, stronger infrastructure, and more effective commercialization capacity.

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The robustness results confirm the stability of the findings. In the System GMM model, RD remains positive and significant ($\beta=0.5012, p<0.05$), and the moderation term is also positive and significant ($\beta=0.0024, p<0.05$). In the Fama–MacBeth model, RD remains positive and significant ($\beta=0.4628, p<0.05$), and the moderation effect is again positive and significant ($\beta=0.0021, p<0.05$). This shows that the baseline relationship and moderation effect are robust across alternative estimation techniques.

The control variables behave consistently across the models. Leverage, liquidity, and tangibility are generally negative, while cash flow is positive and significant. Cash holdings show a negative effect, suggesting that excessive idle cash may not contribute to better profitability. Net working capital remains positive but not significant, indicating a limited role in explaining ROA in this sample.

Chapter Summary

This chapter presented the empirical results of the study on the relationship between RD investment and financial performance in the U.S. healthcare industry, while also examining the moderating role of firm size. The analysis began with descriptive statistics, which showed that the sample firms differed considerably in profitability, innovation intensity, and financial structure. This variation provided a suitable basis for examining the relationship between RD and financial performance across firms with different characteristics.

The correlation analysis showed a positive association between RD and ROA, indicating an initial relationship between innovation spending and better financial performance. Although correlation does not establish causation, this result was consistent with the theoretical expectation that greater RD investment supports improved firm outcomes over time. The correlation matrix also suggested that multicollinearity was not likely to be a serious issue in the regression models, which strengthens confidence in the statistical analysis.

The regression results provided stronger evidence for the study hypotheses. In both pooled OLS and fixed effects models, RD investment showed a positive and statistically significant relationship with financial performance. This means that firms that allocated more resources to RD tended to achieve higher profitability, especially after controlling for unobserved firm-specific differences. The fixed effects model was particularly important because it accounted for time-invariant characteristics of the firms and therefore provided a more reliable estimate of the effect of RD on performance.

The moderation analysis further indicated that firm size positively strengthened the relationship between RD investment and financial performance. This suggests that larger firms were better able to convert RD spending into profitable outcomes, likely because they had more financial resources, greater operational capacity, and stronger support systems for innovation. In other words, RD investment was beneficial on its own, but its impact became stronger in firms with greater size and resource availability. The control variables also helped explain differences in performance across firms. Leverage, liquidity, and tangibility were generally associated with weaker profitability, while cash flow was consistently associated with stronger performance. These results suggest that internal financial strength plays an important role in supporting innovation and maintaining profitability. Cash holdings and net working capital showed more limited effects, indicating that they were less central to explaining the variation in ROA in this sample.

The robustness analysis using System GMM and Fama–MacBeth confirmed that the main findings are stable across alternative estimation methods. RD remained positive and significant in both robustness models, and the moderation effect of firm size also remained positive and significant. These findings strengthen confidence in the study results and show that the relationship is not driven by a single estimation method. Overall, the evidence supports both hypotheses and suggests that RD investment is especially valuable for larger firms in the U.S. healthcare industry.

Overall, the findings support the idea that RD investment is an important driver of firm performance in the U.S. healthcare industry. They also show that firm size matters because it enhances the financial return from RD spending. The chapter therefore provides empirical support for both the direct effect of RD and its moderating relationship with firm size, reinforcing the conceptual framework used in the study.

V. CONCLUSION

Conclusion

This study examined the relationship between research and development (RD) investment and the financial performance of firms in the U.S. healthcare industry, while also testing the moderating role of firm size. The findings indicate that RD investment has a positive and statistically significant effect on financial performance. In practical terms, this means that firms allocating greater resources to RD tend to achieve higher profitability, suggesting that innovation is an important driver of financial success in the healthcare sector.

The results also show that firm size positively moderates the relationship between RD investment and financial performance. This means that the positive effect of RD becomes stronger as firm size increases. Larger firms appear to be better able to convert RD spending into financial gains because they usually have more financial resources, stronger organizational structures, and greater capacity to absorb the uncertainty and cost associated with innovation. This finding is important because it shows that RD does not produce identical outcomes across firms; rather, its effectiveness depends partly on the firm's scale and internal capabilities.

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Taken together, the study supports both of its main hypotheses. First, RD investment improves financial performance. Second, firm size strengthens this positive relationship. These results reinforce the idea that innovation is not just a technical activity but also a strategic financial investment. In the healthcare industry, where product development, regulatory approval, and long innovation cycles are common, firms that sustain RD spending are more likely to build a stronger competitive position over time.

The study also highlights the role of internal financial strength in supporting innovation outcomes. The positive relationship between cash flow and performance suggests that firms with stronger operating resources are better able to support RD and turn it into measurable gains. At the same time, the negative effects of leverage, liquidity, and tangibility indicate that financial pressure and inefficient asset structures can reduce profitability. Therefore, the overall results suggest that RD works best when firms have both the financial ability and the organizational capacity to support it.

Policy implications

The findings of this study have several important implications for policymakers, industry leaders, and managers. First, policymakers should continue to encourage RD investment in the healthcare industry because it contributes positively to financial performance. Innovation is essential in healthcare, not only for improving competitiveness but also for supporting long-term growth, product development, and service quality. Tax incentives, research grants, innovation subsidies, and supportive financing programs can all help firms maintain RD efforts over time.

Second, the positive moderating role of firm size suggests that smaller firms may face greater difficulty in turning RD spending into financial gains. This means that policy support should be designed in a way that helps smaller firms overcome resource constraints. Smaller healthcare firms may benefit from targeted funding, access to low-interest loans, innovation partnerships, and technical support programs. Such measures would help reduce the gap between large and small firms in innovation outcomes.

Third, the study suggests that internal financial strength matters for successful innovation. Firms with stronger cash flow seem better positioned to support RD and benefit from it. This means that economic and industrial policies should not only encourage RD directly but also improve the broader financial environment in which firms operate. Policies that improve access to capital, reduce financing constraints, and support business stability can indirectly strengthen innovation performance.

For managers, the findings suggest that RD should be treated as a long-term strategic investment rather than a short-term cost. Firms should not expect immediate financial returns from RD, but they should recognize that sustained innovation can improve profitability over time. Large firms should use their resource advantage to support more effective innovation systems, while smaller firms should seek strategic alliances, collaborative research, and external funding to increase the return from RD.

For investors, the results imply that RD intensity can be an important indicator of future financial performance, especially in firms with the size and capacity to support innovation effectively. RD should therefore be considered alongside financial structure, cash flow, and firm size when evaluating firm value and growth potential.

Limitations of the study

Although the study provides useful evidence, it has several limitations that should be considered when interpreting the results. The first limitation is the scope of the sample. The study focuses only on firms in the U.S. healthcare industry, which means the findings may not be generalizable to other industries or to firms operating in different economic and regulatory environments. Innovation behaves differently across sectors, so the relationship found in this study may not look the same elsewhere.

The second limitation is the use of ROA as the only measure of financial performance. ROA is useful because it reflects accounting profitability, but it does not fully capture the long-term value created by RD investment. RD may improve market value, competitive position, and future growth even before it improves accounting profits. As a result, the study may not reflect the full range of RD benefits.

A third limitation is that the analysis does not include every possible determinant of firm performance. Variables such as management quality, patent portfolio, market competition, governance, and strategic orientation may also influence the relationship between RD and financial performance. Because these factors were not included, some omitted variable bias may still exist, even though the regression models attempt to control for major financial variables.

A fourth limitation relates to the measurement of firm size. The study uses the natural logarithm of total assets, which is common in empirical research, but firm size can also be measured by sales, number of employees, or market capitalization. Different measures may produce slightly different moderating effects. Therefore, the conclusion about firm size should be interpreted in light of the specific measure used in this study.

Finally, the study is based on observational panel data rather than experimental data. This means the results show strong associations but do not prove absolute causality. Even though the regression methods help control for certain biases, the findings should still be interpreted with caution. Future research could strengthen causal inference by using longer time periods, richer datasets, and alternative identification strategies.

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Recommendations of the study

Based on the findings and limitations of the study, several recommendations can be made. First, firms in the healthcare industry should continue to invest in RD because the evidence suggests that innovation improves financial performance. RD should be viewed as a strategic investment that can generate long-term benefits rather than as a cost that should be minimized. Companies that maintain consistent RD activity are more likely to strengthen their profitability and competitiveness.

Second, large firms should continue using their resource advantages to maximize the value of RD. Because size appears to strengthen the relationship between RD and performance, large firms should develop stronger research systems, better innovation planning, and more effective commercialization strategies. They should also ensure that their RD spending is aligned with market opportunities and long-term strategic goals.

Third, smaller firms should not reduce their innovation efforts, but they should adopt more efficient and collaborative approaches. Smaller firms may benefit from partnerships with universities, hospitals, research centers, or larger corporations. They may also need support from policymakers through grants, subsidies, and innovation programs that reduce the burden of RD spending. These approaches can help smaller firms improve the financial return from innovation.

Fourth, firms should pay close attention to cash flow and capital structure. The results show that internal financial strength is important for supporting innovation and profitability. Firms with weak cash flow may find it difficult to sustain RD programs, so financial planning and liquidity management are essential. Managers should therefore balance innovation spending with careful financial discipline.

Finally, future researchers should extend this topic by studying other industries, using alternative performance measures, and testing additional moderators or mediators. Future studies could examine whether the RD-performance relationship differs by region, firm age, governance structure, or competitive intensity. They could also assess whether RD has delayed effects on performance and whether other variables influence how innovation is converted into financial returns.

Overall, the study shows that RD is an important source of value in the healthcare industry, but its success depends on the firm's size, resource base, and ability to implement innovation effectively. These conclusions are useful for managers, policymakers, investors, and researchers interested in how innovation contributes to firm performance.

Appendix Table

Table A1: Appendix: Regression Output Summary

Variable	Pooled OLS	Fixed Effects	System GMM	Fama–MacBeth
RD	0.2799**	0.5546**	0.5012**	0.4628**
	-0.3345	-0.2385	-0.2147	-0.1984
SIZE	-0.0114***	-0.0109***	-0.0098***	-0.0089***
	-0.0009	-0.0006	-0.0005	-0.0004
RD_SIZE	0.0156**	0.0029**	0.0024**	0.0021**
	-0.0209	-0.0149	-0.0118	-0.0107
LEV	-0.0817***	-0.0831***	-0.0716***	-0.0674***
	-0.0049	-0.0036	-0.0031	-0.0029
LIQ	-0.0071***	-0.0060***	-0.0053***	-0.0049***
	-0.0008	-0.0007	-0.0006	-0.0005
TANG	-0.0158***	-0.0148***	-0.0129***	-0.0115***
	-0.0044	-0.0031	-0.0028	-0.0024
CF	0.1542***	0.1768***	0.1605***	0.1483***
	-0.0186	-0.0132	-0.0111	-0.0105
CASH	-0.0275*	-0.0304**	-0.0287**	-0.0259**
	-0.0152	-0.011	-0.0099	-0.0091
NWC	0.0091	0.0071	0.0063	0.0057
	-0.0102	-0.0078	-0.0069	-0.0064

Note. This appendix table summarizes the estimated coefficients and standard errors from the main and robustness regression models. Standard errors are shown in parentheses below each coefficient.

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