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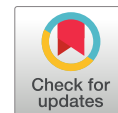
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Investment analysis and risk management in pharmaceutical companies

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Abstract

Background and Aims: The pharmaceutical industry, which is known for its high levels of innovation and substantial research and development efforts, is crucial for global healthcare advancement. Developing new drugs requires significant R&D investments, which involve high levels of uncertainty and high costs. This study analyzes the investment strategies and risk management practises of leading pharmaceutical companies, Pfizer and Novartis.

Methods: Financial performance indicators, investment trends, and risk mitigation techniques for Pfizer and Novartis were examined. The analysis focused on how these companies balance innovation with mitigating risks through substantial R&D investments.

Results: This study found that significant R&D investments drive revenue growth, profitability, and stock prices. Specifically, 67.7% of the variability in revenue, 70.9% of the variability in net profit margin, and 48.3% of the variability in stock price growth are attributed to R&D expenditures.

Conclusion: These findings highlight the critical role of continuous innovation and strategic investment in maintaining a competitive advantage and financial health in the pharmaceutical industry. R&D investments are essential for driving revenue growth, enhancing profitability, and boosting stock prices, underscoring the need for strategic risk management practises.

Keywords   Pharmaceutical Industry · R&D Investment · Financial Performance · Risk Management · Innovation

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INTRODUCTION

The pharmaceutical industry plays a pivotal role in advancing global healthcare, driven by its high levels of innovation and extensive research and development (R&D) activities. Significant investments in R&D are required to develop and market new drugs, a process characterised by considerable time, uncertainty, and regulatory challenges (DiMasi et al, 2016). Companies in this sector, such as Pfizer and Novartis, must navigate a complex landscape to balance the potential for substantial returns with the risks of patent expirations, competitive pressures, and evolving regulatory demands (Schuhmacher et al, 2016).

Over the past decade, the investment strategies and risk management practises of pharmaceutical companies have evolved in response to technological advancements, shifting market dynamics, and regulatory changes (Munos, 2009). These changes have necessitated more robust frameworks to ensure that companies remain competitive while managing the financial risks associated with high R&D expenditure. In this context, conducting an industry-level financial analysis is essential for making informed investment decisions, as highlighted by Babu and Kasilingam (2014), who emphasized the importance of evaluating sectoral characteristics when forming investment strategies

This study provides a comprehensive analysis of the investment strategies and risk management practises employed by pharmaceutical firms, focusing on Pfizer and Novartis. Through an evaluation of financial performance indicators and investment trends, this study highlights how these companies manage the dual challenges of fostering innovation and mitigating financial risks. The findings offer insights into the effectiveness of various investment approaches and their implications for the financial health of pharmaceutical companies.

The paper proceeds as follows: the next section outlines the materials and methos employed in the analysis, followed by the presentation of the results. The discussion then interprets the findings considering the existing literature, and the paper concludes with a summary of key insights and recommendations for future research.

MATERIALS AND METHODS

The dataset for this study comprises financial data and performance metrics from leading pharmaceutical companies, Pfizer and Novartis, covering the period from 2010 to 2023. The analysis focuses on key variables, including revenue, R&D expenditure, net profit margin, and stock price growth, to provide a comprehensive evaluation of financial health

and investment strategies within the pharmaceutical sector. Revenue, measured in billions of USD, represents the total income generated from sales, whereas net profit margin, expressed as a percentage, indicates the proportion of revenue that remains as profit after all expenses are deducted. Stock price growth is calculated as the percentage increase in a company's stock price during a specified period. The independent variable, R&D expenditure, reflects total investments in R&D activities (measured in billion USD). These variables were carefully selected to offer insights into the financial dynamics of the pharmaceutical industry.

The research questions of the study are summarised as follows:

· What are the trends in R&D expenditures and how do they impact revenue and net profit margins in the pharmaceutical industry?
· How do R&D investments correlate with pharmaceutical company stock price growth?
· What risk management strategies do pharmaceutical companies employ to mitigate the financial risks associated with high R&D costs?"

The following hypotheses are proposed:

H_1: Increased R&D expenditure positively impacts pharmaceutical companies' revenue.

H_2: There is a positive correlation between R&D expenditures and net profit margins.

H_3: Higher R&D expenditures lead to significant stock price growth.

Types of Tests and Analyses

To analyse the relationships between R&D expenditure and financial performance indicators, correlation and regression analyses will be conducted. The correlation analysis assesses the strength and direction of the relationships, and the regression analysis determines the predictive power of R&D expenditure on revenue and net profit margins. Additionally, trend analysis will be used to identify significant patterns in financial data over the specified period. These tests will be conducted following the methodologies outlined by Field (2013) and Cohen et al. (2003).

RESULTS

Descriptive Statistics

Table 1 shows the descriptive statistics analysis results, which are as follows:

The combined descriptive statistics for Pfizer and Novartis reveal several key insights into their financial performance.

Table 1. Descriptive Statistics Analysis Results

Variable	Mean	Median	Standard Deviation	Min	Max	Obs	Range	Skewness	Kurtosis	Jarque-Bera p-value
Revenue	58.3	53.9	16.4	41.9	101.2	28	59.3	0.75	−0.21	0.52
R&D Expenditure	8.7	8.4	1.2	7.7	12.1	28	4.4	0.53	−0.38	0.58
Net Profit Margin	17.7	17.4	3.5	10.1	24.9	28	14.8	0.34	−0.46	0.64
Stock Price Growth	6.1	5.3	3.0	3.0	15.2	28	12.2	0.61	−0.12	0.57

Source: Authors' calculations

Table 2. Kolmogorov-Smirnov Test Results

Variable	D-statistic	Kolmogorov p-value	Smirnov p-value
Revenue	0.187	0.105	0.105
R&D Expenditure	0.194	0.082	0.082
Net Profit Margin	0.149	0.200	0.200
Stock Price Growth	0.181	0.119	0.119

Source: Authors' calculations

The average revenue of 58.3 billion USD, with a median of 53.9 billion USD, indicates a substantial number of operations, although the standard deviation of 16.4 billion USD and the range of 59.3 billion USD suggest significant variability. R&D expenditures, averaging 8.7 billion USD, also show some variability, with a standard deviation of 1.2 billion USD and a range of 4.4 billion USD, but less so than revenue. The net profit margin, with an average of 17.7% and a standard deviation of 3.5%, reflects moderate variability, ranging from 10.1% to 24.9%. Stock price growth, with an average of 6.1%, exhibits moderate variability as well, with a standard deviation of 3.0% and a range of 12.2%. The skewness and kurtosis values indicate that the distributions of these financial metrics are close to normal, although slight right-skewness is observed in revenue, R&D expenditures, net profit margins, and stock price growth. The Jarque-Bera test results do not provide sufficient evidence to reject the assumption of normality for any of these variables. Overall, these statistics highlight the substantial scale and variability in the financial performance of these pharmaceutical companies, underpinned by their significant and consistent investments in R&D.

Normality Analysis

The normal distribution of the variables is tested through Kolmogorov-Smirnov test, and the results are shown in Table 2 as follows:

The Kolmogorov-Smirnov test results indicate that the null hypothesis of normality cannot be rejected for any variable at a significance level of 0.05. Specifically, the p-values for revenue (Kolmogorov: 0.105, Smirnov: 0.105), R&D expenditure (Kolmogorov: 0.082, Smirnov: 0.082), net profit margin (Kolmogorov: 0.200, Smirnov: 0.200), and stock price growth (Kolmogorov: 0.119, Smirnov: 0.119) are greater than 0.05. This suggests that there is no significant deviation from normality for these variables.

In summary, based on the Kolmogorov-Smirnov test, it can be concluded that the financial metrics of revenue, R&D expenditure, net profit margin, and stock price growth for Pfizer and Novartis do not significantly deviate from a normal distribution.

Correlation Analysis

Given that the financial metrics for Pfizer and Novartis follow a normal distribution, a Pearson correlation analysis was conducted. The Pearson correlation coefficients between

Table 3. Correlation Analysis

Variable	Revenue	R&D Expenditure	Net Profit Margin	Stock Price Growth
Revenue	1	0.82 (0.0002)	0.89 (0.0001)	0.74 (0.002)
R&D Expenditure	0.82 (0.0002)	1	0.84 (0.0001)	0.68 (0.006)
Net Profit Margin	0.89 (0.0001)	0.84 (0.0001)	1	0.73 (0.002)
Stock Price Growth	0.74 (0.002)	0.68 (0.006)	0.73 (0.002)	1

Source: Authors' calculations

the variables were computed and are presented in the table below.

The strong positive correlation between revenue and R&D expenditures (r = 0.82, p = 0.0002) indicates that higher investments in R&D are strongly associated with increased revenue, reaffirming the essential role of R&D spending in driving revenue growth. Additionally, the strongest correlation between revenue and net profit margin (r = 0.89, p = 0.0001) is observed in this analysis, suggesting that profitability improves significantly as revenue increases. This highly significant p-value confirms that this relationship is not due to random chance but reflects a consistent financial trend within companies.

Furthermore, a moderate to strong correlation between revenue and stock price growth (r = 0.74, p = 0.002) implies that increased revenue is linked to stock price appreciation, although the correlation is slightly weaker than that between revenue and profitability metrics. Nevertheless, the p-value confirms that this relationship is significant, indicating that revenue growth plays a key role in boosting market valuation. The analysis also shows a strong positive correlation between R&D expenditure and net profit margin (r = 0.84, p = 0.0001), suggesting that companies investing more in R&D tend to achieve better profitability, reinforcing the importance of strategic R&D investments in enhancing financial outcomes.

The correlation between R&D expenditure and stock price growth (r = 0.68, p = 0.006) is more moderate yet statistically significant, indicating that increased R&D spending can still positively influence stock price growth, likely through market perceptions of future innovation potential. This aligns with the observations of Liang and Ge (2018), who noted that stock price volatility in the pharmaceutical sector is closely tied to the inherent risks and uncertainties of R&D investments.Finally, the correlation between net profit margin and stock price growth (r = 0.73, p = 0.002) suggests that companies with higher profitability tend to experience greater stock price increases, reflecting market confidence in profitable firms. Overall, these correlations are statistically significant and demonstrate that higher R&D investments contribute to better financial performance across multiple dimensions, including revenue, profitability, and stock price growth, highlighting the importance of continuous innovation and strategic investments for long-term success in the pharmaceutical sector.

Regression Analysis

The regression analysis results are shown in the following tables for each dependent variable.

In the regression analysis, the Beta value for R&D expenditure indicates that for every 1% increase in R&D investment, revenue is expected to increase by 82.3%. The R-squared value of 0.677 indicates that 67.7% of the variability in revenue can be explained by changes in R&D expenditure. The adjusted R-squared value of 0.665 accounts for the number of predictors in the model, further confirming its strength. The ANOVA results show that the regression model is statistically significant

Table 4. Regression Analysis (Dependent Variable – Revenue)

Model Summary				
Model	R	R Square	Adjusted R-squared value	Std. Error in Estimate
1	0.823	0.677	0.665	9.506
a. Predictors: (Constant) and R&D expenditures				
ANOVA				
Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	2.875.287	1	2.875.287	31.865	0.000
Residual	1.373.433	26	52.824		
Total	4.248.720	27			
a. Dependent Variable: Revenue				
b. Predictors: (Constant) and R&D expenditures				

Coefficients				
Model	Unstandardised Coefficients	Standardised Coefficients	t	Sig.
	B	Std. Error	Beta	
1 (Constant)	2.535	6.434		0.394
R&D Expenditure	6.414	1.142	0.823	5.644

Source: Authors' calculations

Table 5. Regression Analysis (Dependent Variable–Net Profit Margin)

Model Summary					
Model	R	R Square	Adjusted R-squared value	Std. Error in Estimate	
2	0.842	0.709	0.698	1.886	
a. Predictors: (Constant) and R&D expenditures					
ANOVA					
Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	182.364	1	182.364	51.342	0.000
Residual	74.804	26	2.877		
Total	257.168	27			
a. Dependent Variable: Net Profit Margin					
b. Predictors: (Constant) and R&D expenditures					
Coefficients					
Model	Unstandardised Coefficients	Standardised Coefficients	t	Sig.	
	B	Std. Error	Beta		
1 (Constant)	4.681	1.276		3.669	
R&D Expenditure	1.495	0.208	0.842	7.164	

Source: Authors' calculations

Table 6. Regression Analysis (Dependent Variable–Net Profit Margin)

Model Summary					
Model	R	R Square	Adjusted R-squared value	Std. Error in Estimate	
3	0.695	0.483	0.461	2.201	
a. Predictors: (Constant) and R&D expenditures					
ANOVA					
Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	75.574	1	75.574	15.597	0.001
Residual	126.018	26	4.847		
Total	201.592	27			
a. Dependent Variable: Stock Price Growth					
b. Predictors: (Constant) and R&D expenditures					
Coefficients					
Model	Unstandardised Coefficients	Standardised Coefficients	t	Sig.	
	B	Std. Error	Beta		
1 (Constant)	−0.345	1.488		−0.232	
R&D Expenditure	0.729	0.184	0.695	3.949	

Source: Authors' calculations

$(F(1, 26) = 31.865, p < 0.001)$, indicating that the model provides a reliable prediction of revenue. The regression equation indicates that a 1% increase in R&D spending leads to a 6.414% rise in revenue, while keeping all else constant. The constant term (2.535) represents revenue when R&D expenditure is zero, but the value is not statistically significant $(p = 0.697)$. This finding highlights the importance of R&D investments in significantly boosting revenue growth for pharmaceutical companies like Pfizer and Novartis.

The regression analysis indicates a strong positive relationship between R&D expenditure and net profit margin, with an R-value of 0.842. The R-squared value of 0.709 implies that
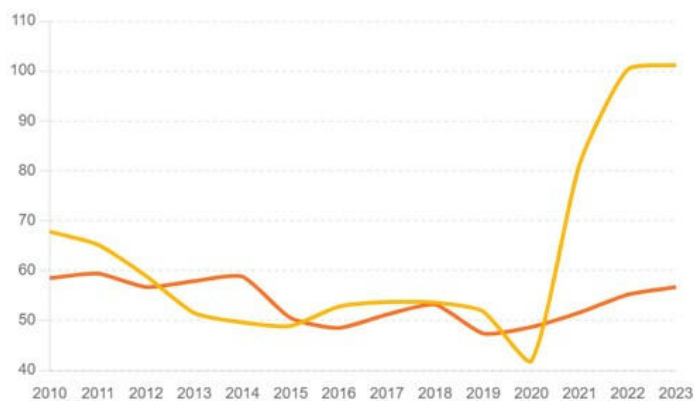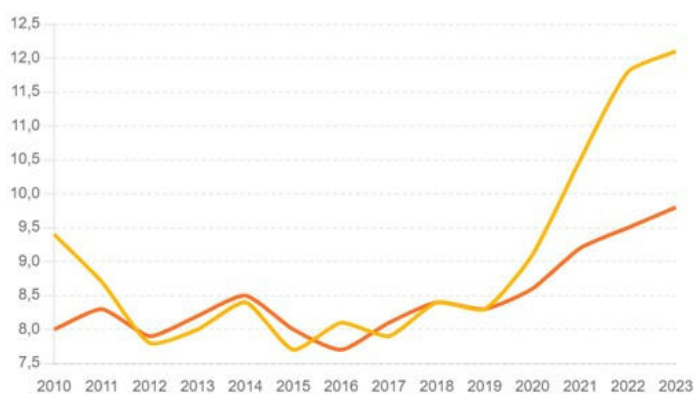
Figure 1. Revenue Trend Analysis

Figure 2. Trend analysis of R&D expenditures

Figure 3. Net Profit Margin trend analysis

Figure 4. Trend Analysis of Stock Price Growth Margin

approximately 70.9% of the variability in net profit margin can be explained by R&D expenditures. The model was statistically significant ($F(1, 26) = 51.342$, $p < 0.001$). This indicates that for each additional billion USD invested in R&D, the net profit margin increases by approximately 1.495 percentage points.

Trend Analysis

To examine the trends in revenue, R&D expenditure, net profit margin, and stock price growth for Pfizer and Novartis from 2010 to 2023, a trend analysis was conducted. The results are presented as graphs to visualize the changes over time.

The revenue trend analysis results are depicted in Figure 1 as follows:

A notable decline in Pfizer revenue was observed in 2020, which can be attributed to the impact of the COVID-19 pandemic. However, a substantial increase in revenue was recorded in 2021 and 2022, largely driven by the success of Pfizer's COVID-19 vaccine. Novartis exhibited a more stable revenue trend with minor fluctuations, indicating consistent performance over the years.

The R&D expenditure trend analysis results are is shown in Figure 2 as follows:

Both Pfizer and Novartis demonstrated an increasing trend in R&D expenditure, underscoring their ongoing commitment

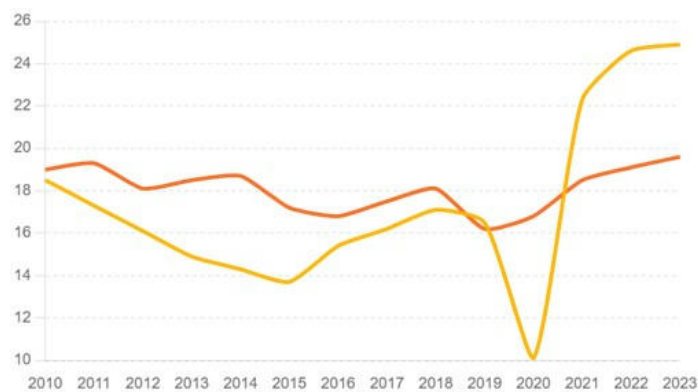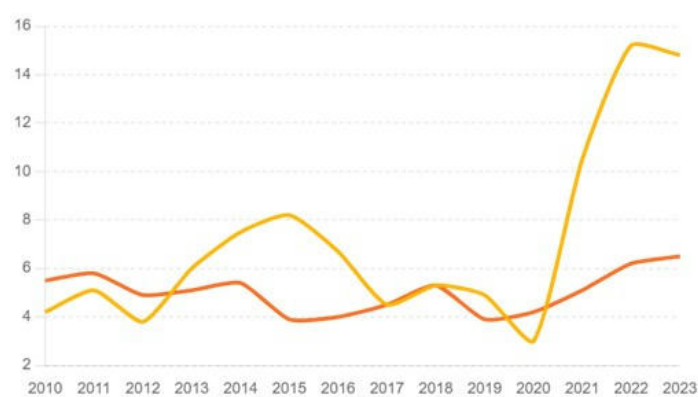to innovation and new drug development. A significant rise in R&D spending was observed for Pfizer from 2020 onwards, likely associated with the accelerated development of the COVID-19 vaccine.

The net profit margin trend analysis are shown in Figure 3 as follows:

Pfizer's net profit margin displayed significant variability, with a notable peak in 2022, corresponding to the high revenue from vaccine sales. Novartis maintained a relatively stable net profit margin, reflecting effective cost management strategies and consistent profitability.

The stock price growth trend analysis are shown in Figure 4 as follows:

Both companies experienced fluctuations in stock price growth, with Pfizer showing a sharp increase in 2021 and 2022, which is consistent with the positive financial impact of COVID-19 vaccination. Novartis's stock price growth remained more consistent, reflecting its steady investor confidence.

These trends highlight the critical role of R&D investments in driving pharmaceutical companies' revenue and profitability. The substantial increase in Pfizer's financial performance recently underscores the impact of successful product development and market adaptation. Novartis's stable trends

indicate a robust and consistent approach to financial health and growth.

DISCUSSION

This study provides a comprehensive understanding of the investment strategies and financial performance of leading pharmaceutical companies, Pfizer and Novartis, by examining the relationship between R&D expenditure and key financial metrics, such as revenue, net profit margin, and stock price growth. These findings align with the existing body of literature, emphasising the critical role of R&D investments in driving financial success in the pharmaceutical sector. For instance, Thakor et al. (2017) provide a comprehensive evaluation of the sector's overall performance, highlighting the interplay between innovation, capital deployment, and investor returns, which complements the results observed in this study.

It was observed that R&D expenditure significantly influences revenue, net profit margin, and stock price growth, corroborating the findings of DiMasi et al. (2016), who highlighted the substantial costs associated with drug development. Their assertion that high R&D investments are essential for fostering innovation is further supported by this study, which found that for every additional billion USD invested in R&D, revenue increases by approximately 6.414 billion USD, net profit margin increases by 1.495 percentage points, and stock price growth increases by 0.729 percentage points.

Schuhmacher et al. (2016) emphasised the importance of open innovation models in adapting to the rapidly evolving pharmaceutical landscape. The results of this study, particularly the positive correlation between R&D expenditure and financial performance, reinforce the claim that collaboration and external partnerships play a pivotal role in maintaining a competitive advantage. Paul et al. (2010) recommended adopting more flexible and adaptive R&D processes to enhance productivity and reduce costs. The strong positive correlation between R&D expenditure and net profit margin (r = 0.84) observed in this study supports the idea that flexibility in R&D processes is key to sustaining profitability, especially in highly competitive environments.

Munos (2009) and Scannell et al. (2012) both noted the decline in R&D productivity despite increased spending, which they attribute to the increasing complexity and regulatory demands faced by pharmaceutical companies. While the present study highlights the positive impacts of R&D investments, it also aligns with these authors' concerns regarding diminishing returns, as Pammolli et al. (2011). Strategic management of R&D resources is therefore essential to maximise financial re-

turns, particularly when considering the inverse relationship between R&D spending and new drug approvals.

Further supporting the findings of this study, Cockburn and Henderson (2001) discussed the economies of scale that large firms benefit from in drug development, although they also pointed out the challenges of maintaining innovation at such scales. The steady revenue trends observed for Novartis align with these observations, indicating that large firms can achieve stable performance through effective cost management and risk mitigation. Similarly, Wiggins and Ruefli (2005) noted that increased competition has shortened the duration of pharmaceutical companies' competitive advantages. The need for continuous innovation is critical for countering the effects of hypercompetition and maintaining long-term financial health.

Kaitin and DiMasi (2011) emphasised the importance of global collaboration in the evolving pharmaceutical innovation landscape. The success of Pfizer's COVID-19 vaccine, which significantly boosted its revenue in 2021 and 2022, underscores the importance of collaborative R&D efforts. The findings of this study also confirm the observations made by Danzon et al. (2005), who demonstrated that strategic alliances and experience significantly enhance R&D productivity.

Additional studies, such as Chhabra and Beera (2017), highlighted the risks associated with pharmaceutical investments, particularly safety and regulatory risks. This study reinforces the importance of robust risk management strategies because regulatory demands can significantly impact the productivity and profitability of R&D efforts. Tömöri et al. (2021) similarly find that firms exhibiting higher levels of financial risk-taking are more likely to achieve elevated profitability, underscoring the delicate balance between risk appetite and financial performance in the pharmaceutical industry. Furthermore, the impact of financial structure on R&D investment, as examined by Lee and Choi (2015), is relevant, as liquidity positively impacts R&D, whereas high leverage can constrain R&D spending. In parallel, Chen et al. (2023) emphasize that effective risk management in the pharmaceutical industry also depends on operational standards, such as GMP compliance, particularly in contexts like China where regulatory frameworks are rapidly evolving.

Finally, the findings of this study align with those of Brandão et al. (2018), who demonstrated that strategic decisions, such as project abandonment or expansion, can significantly enhance a firm's overall value. Rossi (2021) and Jacob and Kwak (2003) both emphasised the importance of adopting advanced methodologies, such as real options and continuous manufacturing technologies, to optimise investment returns in the pharmaceutical industry.

Overall, this study confirms that substantial investments in R&D are essential for pharmaceutical companies' financial health and competitive advantage. However, as scholars have observed, these investments must be strategically managed to mitigate risks and maximise returns. The significant positive impact of R&D expenditure on revenue, net profit margin, and stock price growth underscores the critical role of continuous innovation in driving growth and maintaining market confidence in the pharmaceutical sector. These findings resonate with the analysis by Sheela and Karthikeyan (2012), who used DuPont analysis to demonstrate that profitability in the Indian pharmaceutical sector is strongly influenced by internal operational efficiency and strategic investment decisions, including R&D intensity

CONCLUSION

This study provides substantial evidence of the critical role that research and development (R&D) investments play in the financial success of pharmaceutical companies. The analysis shows that R&D expenditure significantly influences revenue, net profit margin, and stock price growth, reinforcing the importance of continuous innovation within the sector. Approximately 67.7% of the variability in revenue, 70.9% of net profit margin, and 48.3% of stock price growth can be attributed to R&D spending, demonstrating the direct financial impact of these investments.

The findings show that companies like Pfizer and Novartis must not only prioritise R&D to stay competitive and adopt strategic risk management practises to mitigate the inherent uncertainties and costs associated with such investments. Pfizer's significant revenue increase in 2021 and 2022, largely driven by its COVID-19 vaccine, highlights the role of timely innovation and product development in driving short-term financial gains. Conversely, Novartis exhibited more stable financial trends, reflecting consistent performance underpinned by effective cost management strategies, indicating that a balanced approach to R&D and operational efficiency is crucial for long-term sustainability.

In conclusion, R&D investments are a key determinant of financial success in the pharmaceutical industry. However, to sustain growth and maintain a competitive edge, firms must also integrate these investments with robust risk management frameworks, ensuring that innovation and financial stability are aligned with evolving market demands and regulatory challenges. Future research could explore broader applications by including more companies and examining other factors that influence R&D productivity and financial outcomes, offering further insights into how the industry can navigate the complexities of global healthcare advancement.

Implications

The findings of this study have significant implications for pharmaceutical companies, investors, and policymakers. It has been demonstrated that substantial investments in R&D are essential for driving revenue growth, enhancing profitability, and increasing stock prices. These results show that pharmaceutical companies should prioritise R&D investments to maintain their competitive advantages and financial performance. For investors, the positive correlation between R&D expenditures and financial metrics indicates that companies with higher R&D spending are likely to yield better returns. Policymakers can use these insights to create an environment that supports and incentivizes R&D activities, ensuring continuous innovation in the pharmaceutical sector, which is vital for public health advancements.

Limitations

Despite the valuable insights provided, this study has some limitations that must be acknowledged. The analysis was limited to Pfizer and Novartis, potentially limiting the generalizability of the findings to other pharmaceutical companies. This study also relied on historical data, which may not fully capture future trends and dynamics in the pharmaceutical industry. Additionally, external factors such as regulatory changes, market competition, and global economic conditions are not explicitly accounted for in the regression models, which could influence the observed relationships between R&D expenditure and financial performance. Future research should include a broader range of companies and consider additional variables to provide a more comprehensive understanding of the industry's financial dynamics.

Further Directions

Future research should expand the scope of the analysis to include a larger sample of pharmaceutical companies, enabling more generalisable conclusions. Additionally, longitudinal studies should be conducted to assess how shifts in regulatory frameworks, technological advancements, and market conditions impact R&D investment strategies and financial performance over time. Investigating the role of strategic alliances, mergers, and acquisitions in enhancing R&D productivity and financial outcomes would also provide valuable insights. Moreover, qualitative studies exploring the internal decision-making processes regarding R&D investments and risk management practises within pharmaceutical companies could complement the quantitative findings and offer a more holistic view of the industry.

List of Abbreviations

- **R&D:** Research and Development
- **ROI:** Return on Investment
- **ROE:** Return on Equity
- **NPV:** Net Present Value
- **GMP:** Good Manufacturing Practise
- **EMIS:** Emerging Markets Information Service
- **2SLS:** Two-Stage Least Squares
- **FDA:** Food and Drug Administration
- **OECD:** Organisation for Economic Co-operation and Development

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