ACADEMIA International Journal for Social Sciences
Volume 4, Issue 3, 2025 ISSN-L (Online): 3006-6638

Impact of Investing in Research and Development on Performance of IT Sector: An Empirical Analysis from Pakistan (2020-2024)

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Received: 10-06-2025 **Revised:** 12-07-2025 **Accepted:** 20-07-2025 **Published:** 02-08-2025

ABSTRACT

This study examines how investment in research and development (R&D) affects company performance. Purpose is to explore financial impact of R&D spending measured by profitability metrics such as Return on Equity (ROE), Return on Assets (ROA), and Earnings Per Share (EPS). Using secondary data and econometric analysis, Study provides insights effectiveness of R&D as a strategic tool for growth. Study suggest a positive and significant relationship between R&D and ROE, although effects on EPS and ROA are not statistically significant. ROE is the most consistent predictor among three variables tested. Researchers and resources dedicated to R&D in Pakistan is also low. This Study supports argument that regular and well-managed R&D investment is important for maintaining a firm's innovation capacity and attaining superior financial outcomes in today's dynamic business atmosphere.

Keywords: *Investment, research and development (R&D), Pakistan, Financial outcomes*

INTRODUCTION

Organizations are always want to improve his market position and stay ahead. R&D has become a key tool for reaching this, as it fosters innovation, introduces new technologies, and generates knowledge. Importance of R&D is summed up in phrases "innovate or perish" and "innovate or evaporate." Pakistan, a rising economy, spends only about 0.2% of GDP on R&D, far under global average of 2.63% (World Bank, 2022). This limited investment is a major hurdle for country in keeping pace with technological expansions and global competition.

Moreover, number of researchers and resources dedicated to R&D in Pakistan is also low. According to UNESCO, country has only a fraction of researchers per million people compared to leading R&D-driven nations like South Korea or Germany. Lack of investment and skilled manpower blocks ability of Pakistani industries to transform and compete in international markets. Regardless of challenges, significance of R&D for Pakistan's growth cannot be overstated. For instance, industrial firms who invest in R&D can see substantial improvements in efficiency, profitability, and market competitiveness. R&D is especially critical, where innovation directly impacts evolution.

In this paper, focuses on industrial companies listed on Pakistan Stock Exchange (PSX) to explore how R&D investment is improving his financial performance. Key purposes of this paper are: 1) Measure level of R&D investment by industrial firms in Pakistan. 2)Examine impact of R&D expenditure on financial performance indicators such as return on assets (ROA), return on equity (ROE), and earnings per share (EPS). Research in Pakistan's exclusive socio-economic and business landscape, this study goals to tie the gap among theoretical implication and practical implementation of R&D. Eventual goal is to offer actionable visions that can contribute to building a resilient, innovative, and competitive industrial economy in Pakistan. Research goals to highlight available potential of R&D in Pakistan and provide insights for companies and policymakers to arrange innovation for economic and industrial growth. Eventually, the aim of this research is to highpoint the available potential of R&D in Pakistan and offer valuable visions for business leaders and policymakers. By highlighting innovation as a strategic priority, this paper seeks to support the development of a more competitive and knowledge-based industrial economy in Pakistan.

Objectives

- Determine relationship between R&D and ROE, ROA, and EPS.
- Test whether R&D expenses cause changes in financial performance.
- Analyze stationarity and correlation of relevant variables

LITERATURE REVIEW

Rahman and Howlader (2022) examined the relationship between R&D spending and company value (as determined by Tobin's Q) and performance (as determined by return on equity and return on assets) in a rising South Asian nation. The study demonstrated a substantial relationship between R and D and every performance metric. R&D expenditure had a beneficial effect on the financial success of sampled organizations, according to another study conducted in India, a country in South Asia. This finding, however, contradicts another study on Indian businesses that discovered a negative short- and medium-term relationship between corporate revenues and R&D investment. Additionally, they came to the conclusion that marketing, labor, and capital expenditures are more likely to significantly affect financial performance than R&D.

Li and Luo (2021) conducted a study on Chinese medical enterprises from 2010 to 2019. Their goal was to test the connection between enterprise performance and R&D inputs. The findings indicated a positive correlation between corporate performance and R&D investment. Sue et al. (2020) looked at the connection between the operational success of Chinese small and medium-sized listed businesses and the level of R&D investment. They came to the conclusion that when an R&D intensity is more than 5%, the link between R&D investment and operational performance is notably unfavorable for small and medium-sized businesses. Moreover, for businesses with less than 5% R&D spending, the link was not significant.

Eldawayaty (2020) examined how the level of R&D activity affected the company value and financial performance (as determined by return on equity and return on sales) of Egyptian listed companies. The study discovered a negative correlation between corporate value and performance and the intensity of research and development. Intangible investment, such as R&D and human capital, is crucial for small and medium-sized businesses. Make the case that small and medium-sized businesses can benefit from investing in intangibles. Their empirical research actually demonstrated that these investments increase a company's worth and profitability. An information panel for 548 firms was created based on the EU Industrial R&D Investment Scoreboard for the years 2003–2013.

According to De Almeida et al. (2019), R&D spending benefits a company's overall sales and operating profit. However, the intensity of R&D affects this relationship. Stated differently, there is a stronger correlation between R&D and performance in organizations with more R&D spending.

A survey of South Korean listed firms from 2012 to 2016 was conducted by Xu et al. (2019). They discovered that whereas major corporations' R&D expenditures have no discernible effect on their financial performance (return on assets and sales), they have a detrimental effect on small businesses' performance. The primary concern was how investments in R&D will affect things in the long run. They found that while R&D expenditure may have a short-term negative impact on business performance, it has a long-term favorable impact. Its lag impact is beneficial, to put it another way. The study also discovered that larger companies typically invest more in research and development, which produces more advanced technologies and more lucrative outcomes. The results of an empirical study on Russian industrial enterprises showed that R&D and innovation expenditures improved the performance of the companies, and that this link grew stronger after a critical mass of innovation investment was reached.

Donkor et al. (2018) investigated the impact of R&D and innovation capabilities on the financial performance of 340 Ghanaian SMEs. They found that R&D and innovation capabilities had a significant favorable effect on financial performance as shown by return on assets.

Lin (2017) assessed how R&D spending affected Taiwanese companies' performance and growth between 2005 and 2014. The performance and market value of the tested companies were found to be positively correlated with R&D investment. In order to examine the effect of research and development on the companies' revenues, a comprehensive survey of 1244 information technology and communication companies operating in Germany, France, Sweden, and the United Kingdom between 2004 and 2013 was conducted. The results showed a significant correlation between information technology and communication companies' revenues and their adoption of R&D activities. According to the study, the impact was higher for startups, small businesses, and people employed in the information technology, internet service, and communication element manufacturing industries. Spending on research and development has a strong and positive association with return on assets, according to a study that was conducted using data gathered for 359 listed businesses on the Vietnam Stock Exchange between 2012 and 2016. A positive, non-linear association between the sampled companies' profitability and R&D intensity was found in a study on Indian pharmaceutical companies that looked at the relationship between the two.

R&D intensity and revenue improvement were found to be positively correlated in Chen et al.'s (2005) study of over 4000 Taiwanese enterprises. A thorough review of earlier research reveals a glaring lack of information regarding the degree to which corporate organizations care about research and development (R&D) and the relationship between such investment and success, particularly in Arabic and Jordanian literature. Despite addressing this issue, their analysis only looked at six pharmaceutical businesses. It is not possible to say that this industry is typical of all industrial businesses. The pharmaceutical industry is predicted to have a higher level of R&D intensity than other industrial business types, according to empirical evidence.

RESEARCH METHODOLOGY

Variables

Independent variable: R&D Expense as Percentage of Sales

Dependent variable: EPS (Earnings Per Share), ROA (Return on Assets), ROE (Return on Equity)

Control variables the size of the company, its age, and the capital invested.

Hypotheses Development

Based on literature review, following hypotheses are developed:

H1: There is a major relationship between R&D investment and Return on Equity (ROE).

H2: There is a major relationship between R&D investment and Return on Assets (ROA).

H3: There is a major relationship between R&D investment and Earnings Per Share (EPS).

H4: R&D investment causes a unit root in financial performance variables.

This study uses a **quantitative approach** with **secondary data**. Econometric model employs regression analysis, Augmented Dickey-Fuller (ADF) tests for unit roots, and correlation analysis.

DATA ANALYSIS & INTERPRETATION

Table 1: Descriptive Statistics

Date: 05/11/25 Time: 00:41
Sample: 1 25

	R_D_EXPEN	EPS	ROA	ROE
Mean	0.167813	7.717200	20.20000	19.10400
Median	0.165246	4.070000	21.00000	18.59000
Maximum	0.348730	29.38000	43.00000	31.71000
Minimum	0.015113	0.120000	10.00000	2.700000
Std. Dev.	0.133617	7.760468	7.555351	9.780811
Skewness	-0.000484	1.298557	0.997347	-0.154284
Kurtosis	1.273452	3.752778	4.421843	1.727521
Jarque-Bera	3.105174	7.616330	6.250465	1.785850
Probability	0.211700	0.022189	0.043927	0.409456
Sum	4.195337	192.9300	505.0000	477.6000
Sum Sq. Dev.	0.428481	1445.397	1370.000	2295.942
Observations	25	25	25	25

R&D Expense has a mean of 16.78%, with moderate variation. It is nearly symmetrically distributed.

EPS has a high variation and is positively skewed, with some extreme high values.

ROA and **ROE** have moderate to high variation, with **ROA** being slightly positively skewed and **ROE** being slightly negatively skewed.

Statistical test shows that **EPS** and **ROA** do not follow a normal distribution, while **R&D Expense** and **ROE** are close to normal.

Table 2: Correlation Analysis

	R_D_EXPEN	EPS	ROA	ROE
R_D_E	1.000000	0.164886	0.067081	0.677042
EPS	0.164886	1.000000	0.005254	0.474575
ROA	0.067081	0.005254	1.000000	-0.123166
ROE	0.677042	0.474575	-0.123166	1.000000

R&D Expense and EPS

0.1649 — Shows a weak positive correlation. It means there is a slight tendency for R&D expenses to increase as EPS increases, but it's not very strong.

R&D Expense and ROA

0.0671 — Very weak positive correlation. R&D expenses and ROA do not appear to have a significant relationship.

R&D Expense and ROE

0.6770 — Strong positive correlation. It suggests that as ROE increases, R&D expenses also tend to increase significantly.

EPS and ROA

0.0053 — Almost zero, indicating no meaningful correlation between EPS and ROA.

EPS and ROE

0.4746 — Moderate positive correlation. As EPS increases, ROE also tends to increase.

ROA and ROE

-0.1232 — Very weak negative correlation. As ROA increases, ROE tends to decrease slightly, but this relationship is very weak.

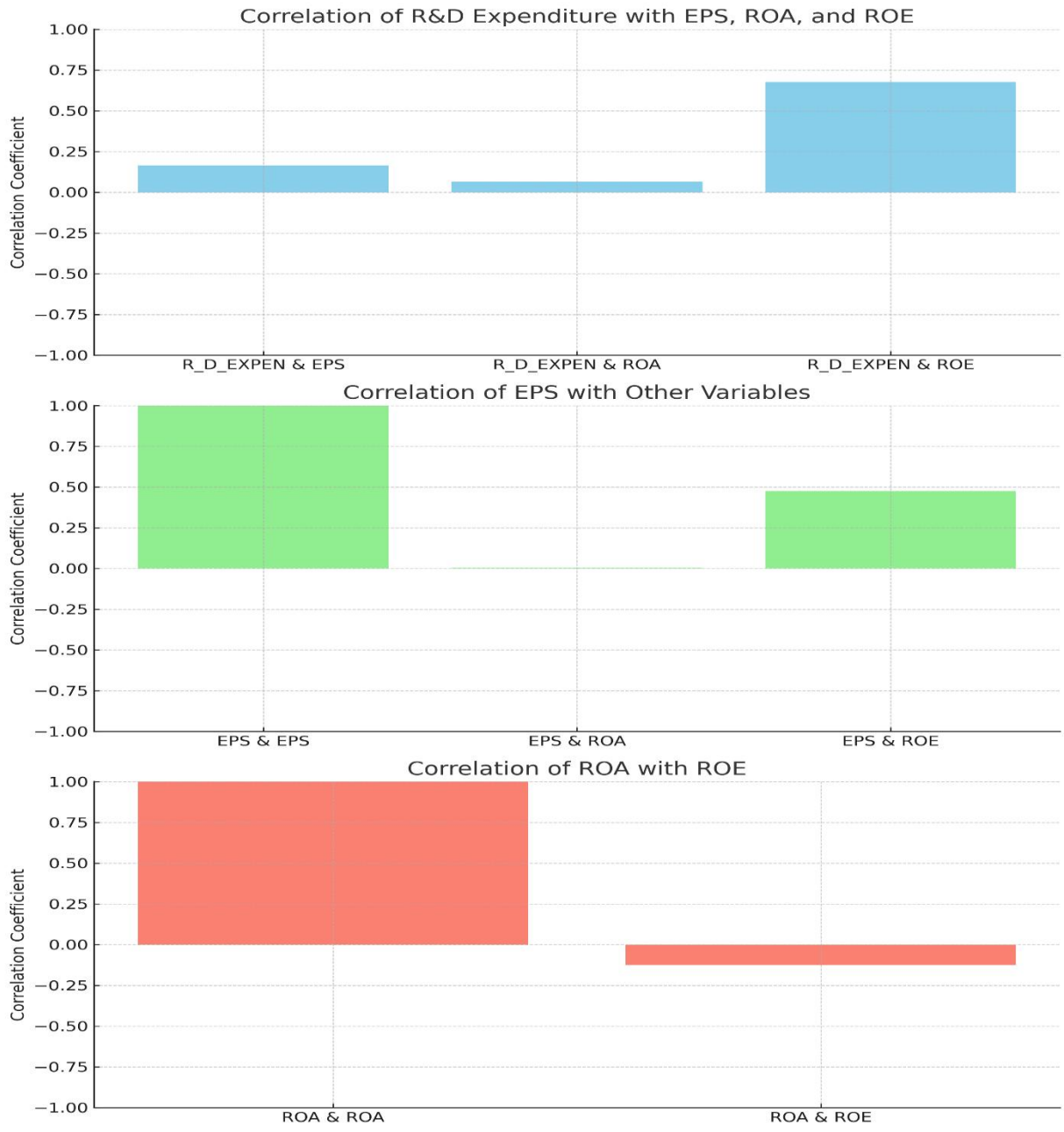

Table 3: Unit Root (ADF) Test

To ensure data stationarity, Augmented Dickey-Fuller tests were performed:

Null Hypothesis: R_D_EXPENSE_AS___OF_SALES has a unit root

Exogenous: Constant
Lag Length: 5 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.123841	0.0054
Test critical values:	1% level	-3.831511	
	5% level	-3.029970	
	10% level	-2.655194	

*MacKinnon (1996) one-sided p-values.
Warning: Probabilities and critical values calculated for 20 observations
and may not be accurate for a sample size of 19

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(R_D_EXPENSE_AS___OF_SALES)
Method: Least Squares
Date: 05/04/25 Time: 13:22
Sample (adjusted): 7 25
Included observations: 19 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
R_D_EXPENSE_AS___OF_SALES(-1)	-1.918458	0.465211	-4.123841	0.0014
D(R_D_EXPENSE_AS___OF_SALES(-1))	1.159673	0.329096	3.523817	0.0042
D(R_D_EXPENSE_AS___OF_SALES(-2))	0.909226	0.271829	3.344839	0.0058
D(R_D_EXPENSE_AS___OF_SALES(-3))	1.031536	0.278047	3.709932	0.0030
D(R_D_EXPENSE_AS___OF_SALES(-4))	0.615583	0.281370	2.187806	0.0492
D(R_D_EXPENSE_AS___OF_SALES(-5))	0.433433	0.249291	1.738664	0.1077
C	0.276747	0.067546	4.097178	0.0015

R-squared	0.697740	Mean dependent var	0.011121
Adjusted R-squared	0.546610	S.D. dependent var	0.100773
S.E. of regression	0.067855	Akaike info criterion	-2.265579
Sum squared resid	0.055252	Schwarz criterion	-1.917628
Log likelihood	28.52300	Hannan-Quinn criter.	-2.206692
F-statistic	4.616827	Durbin-Watson stat	2.151571
Prob(F-statistic)	0.011751		

Null Hypothesis: EPS has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.943089	0.0075
Test critical values:	1% level	-3.808546	

	5% level	-3.020686
	10% level	-2.650413

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EPS)
Method: Least Squares
Date: 05/04/25 Time: 13:24
Sample (adjusted): 6 25
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EPS(-1)	-0.638609	0.161957	-3.943089	0.0015
D(EPS(-1))	-0.272298	0.180123	-1.511734	0.1528
D(EPS(-2))	-0.207237	0.141232	-1.467353	0.1644
D(EPS(-3))	-0.473760	0.127285	-3.722035	0.0023
D(EPS(-4))	-0.311437	0.163987	-1.899151	0.0783
C	1.565766	1.273592	1.229409	0.2392

R-squared	0.798015	Mean dependent var	-0.934000
Adjusted R-squared	0.725878	S.D. dependent var	5.873145
S.E. of regression	3.074984	Akaike info criterion	5.327802
Sum squared resid	132.3774	Schwarz criterion	5.626521
Log likelihood	-47.27802	Hannan-Quinn criter.	5.386115
F-statistic	11.06243	Durbin-Watson stat	1.788496
Prob(F-statistic)	0.000182		

Null Hypothesis: ROA has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.115577	0.0004
Test critical values:	1% level	-3.737853	
	5% level	-2.991878	
	10% level	-2.635542	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ROA)
Method: Least Squares

Date: 05/04/25 Time: 13:25
Sample (adjusted): 2 25
Included observations: 24 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ROA(-1)	-1.060373	0.207283	-5.115577	0.0000
C	21.76170	4.472027	4.866183	0.0001

R-squared	0.543276	Mean dependent var	0.333333
Adjusted R-squared	0.522516	S.D. dependent var	11.10294
S.E. of regression	7.672160	Akaike info criterion	6.992729
Sum squared resid	1294.965	Schwarz criterion	7.090900
Log likelihood	-81.91275	Hannan-Quinn criter.	7.018774
F-statistic	26.16913	Durbin-Watson stat	2.028551
Prob(F-statistic)	0.000040		

Null Hypothesis: ROE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.870033	0.0638
Test critical values:	1% level	-3.737853	
	5% level	-2.991878	
	10% level	-2.635542	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ROE)
Method: Least Squares
Date: 05/04/25 Time: 13:25
Sample (adjusted): 2 25
Included observations: 24 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ROE(-1)	-0.550205	0.191707	-2.870033	0.0089
C	10.27358	3.999502	2.568715	0.0175

R-squared	0.272417	Mean dependent var	0.040000
Adjusted R-squared	0.239345	S.D. dependent var	10.17614
S.E. of regression	8.875178	Akaike info criterion	7.284049
Sum squared resid	1732.913	Schwarz criterion	7.382220

Log likelihood	-85.40859	Hannan-Quinn criter.	7.310094
F-statistic	8.237087	Durbin-Watson stat	2.147516
Prob(F-statistic)	0.008896		

R&D Expense: ADF = -4.123841, p = 0.0054 → Stationary at level
EPS: ADF = -3.943089, p = 0.0075 → Stationary at level
ROA: ADF = -5.115577, p = 0.0004 → Stationary at level
ROE: ADF = -2.870033, p = 0.0089 → Stationary at level

All variables are stationary at their levels and suitable for regression analysis.

Table 4: Regression Output

Regression results are presented below, analyzing the effect of EPS, ROA, and ROE on R&D expenditure:

Dependent Variable: R_D_EXPENSE_AS___OF_SALES
Method: Least Squares
Date: 05/04/25 Time: 13:19
Sample: 1 25
Included observations: 25

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EPS	-0.003712	0.002974	-1.248266	0.2257
ROA	0.002949	0.002709	1.088364	0.2888
ROE	0.010927	0.002378	4.595972	0.0002
C	-0.071861	0.074211	-0.968344	0.3439

R-squared	0.517199	Mean dependent var	0.167813
Adjusted R-squared	0.448228	S.D. dependent var	0.133617
S.E. of regression	0.099252	Akaike info criterion	-1.636659
Sum squared resid	0.206871	Schwarz criterion	-1.441639
Log likelihood	24.45824	Hannan-Quinn criter.	-1.582569
F-statistic	7.498741	Durbin-Watson stat	1.356658
Prob(F-statistic)	0.001353		

Variables: These are the factors that might influence R&D expense as a percentage of sales.

EPS (Earnings Per Share): Shows relationship between R&D expenses and a company's earnings per share. Coefficient is -0.0037, which means that if EPS increases, R&D expenses decrease slightly (but this relationship is not statistically significant, as shown by high p-value of 0.2257).

ROA (Return on Assets): This is relationship between R&D expenses and company's assets. The coefficient is 0.0029, indicating a small positive relationship, but again, this result is not significant because p-value is 0.2888.

ROE (Return on Equity): This shows how R&D expenses change with respect to company's equity. Coefficient is 0.0109, and p-value is very low (0.0002), suggesting that this relationship is statistically significant. So, a higher ROE leads to higher R&D expenses as a percentage of sales.

C (Constant): Constant term (intercept) is -0.0719, which represents value of R&D expense as a percentage of sales when all other variables are zero. This is not statistically significant (p-value = 0.3439).

R-squared: 0.5172 means that approximately 51.7% of variation in R&D expenses can be explained by model's variables. It's a moderate fit.

Adjusted R-squared: 0.4482 adjusts for the number of variables in the model, which shows that even with a few variables, the model is moderately good at explaining data.

F-statistic: 7.4987 tests whether overall model is statistically significant. p-value for F-statistic (0.0014) suggests that model as a whole is statistically significant.

Durbin-Watson statistic: 1.3567 measures autocorrelation (whether residuals are correlated with each other). A value closer to 2 means no autocorrelation, so this value suggests moderate positive autocorrelation.

RESULTS & DISCUSSION

Study suggest a positive and significant relationship between R&D and ROE, although effects on EPS and ROA are not statistically significant. ROE is the most consistent predictor among three variables tested.

ADF results check that all series are stationary, making them valid for econometric study. Correlation matrix shows that R&D investment is most strongly related to ROE.

This supports hypothesis that R&D investments significantly affect shareholder returns, particularly in equity-based performance (ROE), whereas their short-term impact on operational or profitability metrics (EPS and ROA) is weaker.

CONCLUSION

Paper determines that R&D investment has a significant positive effect on ROE, telling that equity investors may advantage from increased R&D spending. But, its effect on other performance metrics remains limited. Companies should study R&D as a long-term investment and emphasis on strategic implementation.

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