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UNTYING THE RELATIONSHIP BETWEEN R&D AND FIRM'S PERFORMANCE: A MEDIATION ANALYSIS OF BSE LISTED COMPANIES IN INDIA

Keywords: R&D expenditure, firm performance, capital structure, mediating effect, GMM.

J E L Classification: O3, L25.

Abstract: This study reveals the capital structure as a moderating effect between R&D Expenditure and firm performance. Capital structure is a major part of a business en-

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terprise that ensures the financial funding for innovation and brings new products to the market. Return on assets (ROA), return on equity (ROE), and return on capital (ROCE) are taken as dependent variables. The authors computed R&D Intensity from the ratio of R&D Expenditure and total sales, which was considered an independent variable. Firm size and capital structure are considered as control variables and mediating variables. Also, this study shows an adverse outcome of R&D Intensity on firm performance using pooled-OLS, fixed-effect, random-effect, and dynamic panel regression for a sample of BSE100 firms for the 2015–2024 to 2023–24 periods. The insight of the study is valuable for the management, policymakers, investors, and government who are interested in R&D Expenditure and in understanding the relationship between R&D Intensity and firm performance.

Introduction

Business competitiveness increases with time. Therefore, companies are developing competitive strategies and innovating new skills. Research and Development (R&D) is a combination of activities where companies undergo deep market research for a particular product or service, innovate and introduce that particular product or service with a minimum production cost. Technology-based companies spend the maximum percentage of expenditure on R&D to benefit from competitive advantage and ensure their position in the market (Kim, Lee, Park & Oh, 2011). Companies with high R&D take a high risk to increase profit. Therefore, companies reduce their production cost through R&D. Activities like R&D need a long period to be effective properly within a company. Optimum uses of R&D should minimize costs and increase companies' sales volume and market share. According to Indian Accounting Standard – 38, R&D costs are written off to the income statement in the year they are incurred, while development costs can be recognized as intangible assets if they meet certain criteria. The capitalization of R&D costs may provide evidence that companies are working on new ideas and technologies that will create future economic benefits (Lantz & Sahut, 2005). R&D perform a major role expanding existing products and processes and innovating new skills and strategies which produce new products and generate new processes (Matheson & Matheson, 1998). A company gains a competitive edge by taking product differentiation with the R&D process. Simply R&D begins with a question "why" or "how". The process towards an answer is R&D, but the R&D and innovation are two different things, we can say two sides to a coin. R&D is mainly technology-oriented, whereas innovation is the process of bringing new products into the market. Basically, money spent by a company on Research and

Development process is to be considered for a tax credit. This scheme was first introduced for SMEs in 2000. In 2002, it launched as R&D Expenditure Credit or Above the Line R&D Tax Relief for large companies. Risk is one of the major factors in innovation which increased the marginal cost of R&D. This scenario leads to underinvestment in R&D and is the reason for the market collapse. Therefore, the government in a developing country like India has introduced various schemes, grants, tax incentives, and loans to set up an economic hemisphere for R&D. There is a myth behind R&D that it is only useful for large companies, which is absolutely wrong. All types or sizes of businesses can get benefits from it. In recent times, many investors are ready to invest in R&D. Basically, government invested in basic and applied research for knowledge creation, but there is always a high amount of uncertainty involved. Government investment in R&D often generates higher social returns than private returns, as its benefits extend beyond individual firms through knowledge spillovers, technological advancement, and broader economic development. However, investment from the private sector is mainly based on experimental development research (EDR), which generates more private return than social return. India invests 0.6% of its GDP in R&D, which is much lower than in other countries (China 2.2% and Israel 5%). India, as the Global Technological Powerhouse, needs to increase investment in R&D. R&D helps a company to achieve a competitive edge in a perfectly competitive market by introducing new technology in products or services. It finds a unique way for a firm to perform in such a way that it gains the competitive advantage. R&D leads to minimization of cost and enhances productivity so that company meets consumer demand in most efficient way. Product differentiation, brand image building, introducing new product or skills, and enhancing revenue growth of the company are the key features of R&D. India spends only 0.6% of its GDP on Research & Development, while the US, for example, spends 2.8%. This difference in numbers explains the scenario of India's lack of innovation in comparison to other countries. On the other hand, we all know that most of the R&D investments are happening in India under the supervision of the government. Therefore, the government plays a vital role in this R&D scenario. Over the past few decades, the Indian government passed some resolutions: Science Policy Resolution, 1958; Technology Policy Statement, 1983; Science and Technology Policy, 2003; and Science, Technology and Innovation Policy, 2013 (Kaushik, Basha & Ganesan, 2020), fueling the technology performance and innovation. Recently, due to impact of the COVID-19 pandemic, the world began to recognize the impor-

tance of R&D. In this context, India may be highlighted as one of the major fields for knowledge-based solution.

Literature Review and Hypotheses

R&D and Firm Performance

Strategic decisions in research and development (R&D) significantly affect the financial health of small- and medium-sized enterprises (SMEs) (Teirlinck, 2017). This study reveals that financial outcomes related to the optimal configuration of R&D decisions depend on the size of the firm and on the time lag under consideration. For the betterment of financial performance, the management needs to pay more attention to research related works, domestic innovation, and the enhancement of absorptive capacity in sets of strategic R&D decisions. Technology-based companies utilize their R&D and marketing resources for commercializing their technology assets (Lin, Lee & Hung, 2006). This research concluded that firms in different technologies should have different technology commercialization strategies. Commercialization orientation and R&D intensity complement each other. One study considers R&D as the knowledge intensity and capital investment in the industry (Chen, Chen, Liang & Wang, 2019). Knowledge can be internally generated or externally sourced. Access to external knowledge is risky due to the fact that external sources are often overlooked. This study concluded that the higher the R&D intensity in the value-added component of human capital, the better the financial performance of the company. As the competition between firms has become increasingly intense, and business becomes increasingly global, the product life cycle has been shortened (Ehie & Olibe, 2010). Past studies concluded that there is a direct relationship between R&D Investment and firm's market value (Bae & Noh, 2001). Therefore, R&D Investment works as a key factor for a firm's future growth. R&D expenditure provides a competitive edge to the firm so that it can easily survive in competitive market (Johannessen, 2008). Chakraborty (2023) highlights that effective governance mechanisms, particularly board independence and active oversight, significantly improve firm performance, suggesting that strong governance structures can also facilitate better strategic investment outcomes, such as R&D efficiency and innovation performance. The relationship between R&D and earnings, operational performance, rev-

enue growth, and market value demonstrate the potential for transformation through the development of new performance metrics. In their paper, Erdogan and Yamaltdinova (2019) examined the impact of R&D on the financial performance of 62 production companies in Istanbul, using panel data methods. They used return on assets (ROA) and return on equity (ROE) as a proxy to measure company's performance, and to measure R&D expenditures we considered the R&D intensity and R&D expenditures over total sales as explanatory variables. In their study, Freihat and Kanakriyah (2017) concluded that R&D expenditure in the current year leads to future advancements, such as higher share price, larger market share, or better reputation in current and subsequent year's. Lantz & Sahut (2005) in their paper concluded that the R&D expenditures can be accounted for expenses or assets. This duality may cause wrong forecasting, which leads to the asymmetry in information. Resende, Monje-Amor and Calvo (2024) offer solid proof that putting money into its R&D helps companies do better. Their research shows that when firms invest in its R&D, they tend to see better results in terms of return on assets (ROA), return on equity (ROE), and return on invested capital (ROIC). Basically, if companies put more cash into its R&D, they are more likely to have better financial results. This backs up the idea that its R&D is a valuable asset that boosts long-term success. But it is not just about how much money you spend on its R&D; it is also about how well you use those resources. Wu, Wang, Chang, Lian and Chen (2022) point out that being good at turning its R&D into useful stuff is key to a company's success. They looked at data from Taiwan's electronics industry and discovered that if a company is efficient at its R&D, it tends to have better accounting-based performance (ROA). Also, if they are good at selling their innovations, they tend to have better market-based performance (Tobin's Q). The bottom line is its R&D helps a company succeed when they can turn that investment into new products and sell them well (Wu et al., 2022). For small and medium-sized businesses (SMEs), things are a bit trickier because they often do not have a ton of resources, which can make its R&D outcomes unpredictable. Son and Zo (2023) found that its R&D resources – especially putting money into its R&D – can really help a company's performance, especially if they are open to new ideas and working with others. They suggest that investing in its R&D improves a company's ability to find outside knowledge and lowers the risks that come with trying to innovate. Overall, the research tends to agree that there is a link between putting money into its R&D and how well a company does, but it also makes it clear

that this link depends on how well a company uses its R&D resources. Based on all of these studies, the authors hypothesize the following:

H1**:** R&D Expenditure has a significant and positive impact on Firm Performance.

The Relationship between R&D and Firm Performance with the Mediating Effect of Capital Structure

Capital structure does not have an impact over the firm value (Modigliani & Miller, 1958), and this famous "irrelevance theory" created a huge controversy at the time. A decade later, the tax deductibility of interest payments was considered, suggesting that firm value increases with financial leverage. Therefore, financing and investing decisions are correlated with each other (Jensen & Meckling, 1976). Hence, the research and development investment can make positive impact over the capital structure. Some existing literature suggests that the capital structure makes valuable impact on firm's strategic decision (Jiraporn, Chintrakarn & Liu, 2011). Capital structure is one of the important variables for profit maximization and growth of the firm. The agency theory suggests that there is an adverse relationship between capital structure and firm performance (Margaritis & Psillaki, 2009). R&D is very difficult to estimate. Therefore, the agency cost problem reveals that debt financing in R&D investment is more difficult and expensive (Ho, Tjahjapranata & Yap, 2006). Also, equity financing may dilute the ownership of the equity shareholders and reduce the wealth of the stakeholders (Hu, Chua, & Chrisman, 2006). So, R&D has uncertain outcomes. But some researchers have argued R&D plays an important role to counter the market competition and gain the competitive edge with knowledge-based intangible asset creation (Barney, 1991). R&D has a negative association with firm's leverage and to counter the competition on the basis of innovation should efficient capital structure (O'Brien, 2003). There is a significant difference in risk associated with the large firm and the small firm. Based on all of these studies, the authors hypothesize the following:

H2: Capital Structure mediates the association between R&D Expenditure and Firm Performance.

Research Gaps

Previous research concluded that R&D expenditure is used for increasing sales volume. However, there is no information that R&D expenditure has a huge impact on the risk, income, and financial performance of a company. Thus, considering the research gap, the main objectives of the study are to identify R&D Expenditure and analyze the firm's performances of the selected Indian companies to know the impact of R&D Expenditure.

Objectives of the Study

- To understand the impact of Research & Development Expenditure on Firm Performances of selected Indian Companies.
- To understand how the Capital Structure mediates the association between Research & Development Expenditure and Firm Performance.

Research Methodology

Data Collection

Data are collected for this study purely based on secondary resources (Ace Analytics). For the purpose of the study, BSE100 companies are considered a sample data for ten consecutive years, from 2014–15 to 2023–24. Finally, 55 companies were selected from BSE100 listed companies on the basis of data availability, excluding financial firms. In this study, quantitative research design was conducted in order to fulfil research objectives and to satisfy the main research question:

RQ: What is the impact of R&D Expenditure on firm's performance?

Variables used in the study

$$\text{R\&D Intensity} = \frac{\text{R\&D Expenditure}}{\text{Total Sales}}$$

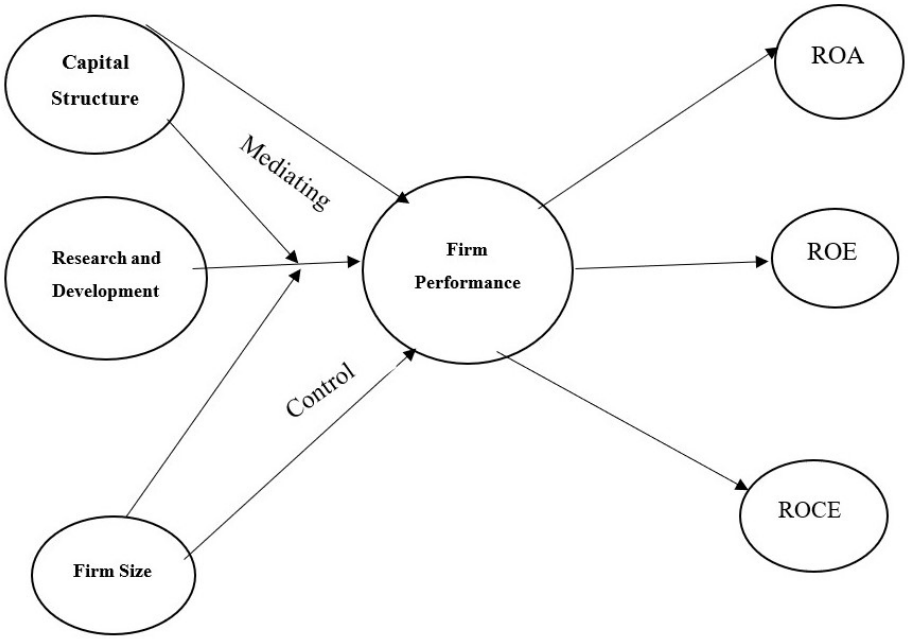
Therefore, R&D Intensity is considered independent variable. Firm's Performance is taken as a dependent variable. To construct a relationship between independent variable and dependent variable, we considered Return on Asset (ROA), Return on Equity (ROE) and Return on Capital Employed (ROCE) (Ayaydin & Karaaslan, 2014). Here, ROA measured company's asset utilization efficiency. ROE measures company's profitability from shareholder's fund. ROCE measures company's capital efficiency. Capital structure is taken as mediating variable, Debt-equity ratio is considered capital structure of the firm. Firm size is considered control variables (Lioui & Sharma, 2012). Log value of total asset is taken for the size of firm.

Table 1. Variable Description

VARIABLE	MEASUREMENT	ACRONYM	VARIABLE
Return on Asset	(EBIT+Depreciation)/ Total Asset	ROA	Dependent Variable
Return on Equity	Net Income/Shareholders' Equity	ROE	Dependent Variable
Return on Capital Employed	EBIT/Capital Employed	ROCE	Dependent Variable
R&D Intensity	R&D Expenditure/Total Sales	RDI	Independent Variable
Firm Size	Natural log of Assets	SIZE	Independent Variable
Capital Structure	Total Debt/Equity	DR	Independent Variable

S o u r c e : prepared by researchers.

Figure 1. Conceptual Framework



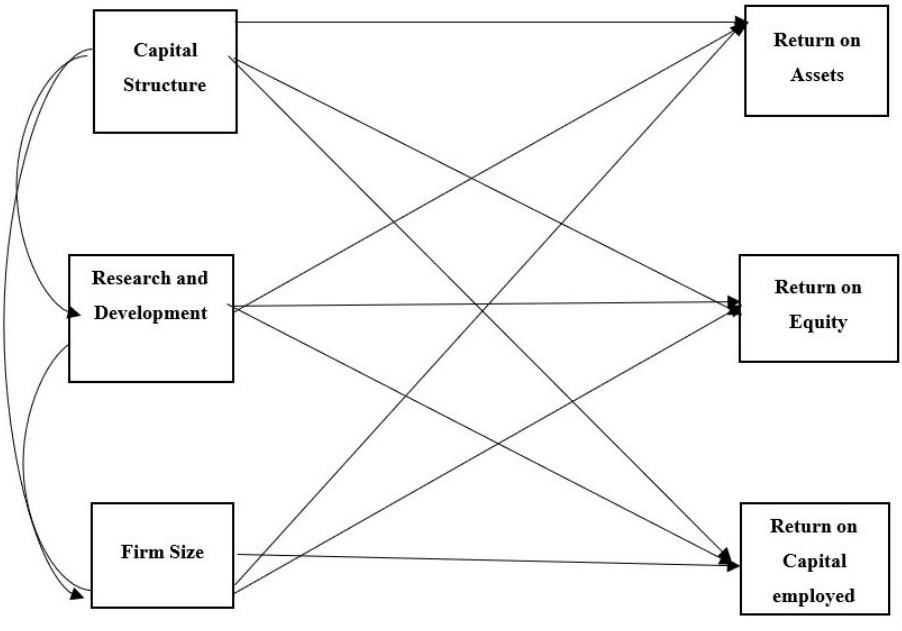
S o u r c e : designed by authors.

Structural Equation Modelling (SEM)

This paper shows the relevance and utility of variables through structural equation modelling. SEM is very fruitful for factor analysis and multiple regression analysis utilized to analyze structural effects between latent and manifest variables.

This paper used STATA to conduct its data analysis among the measured and constructed variables.

Figure 2. Structural Equation Model



S o u r c e : designed by the authors.

In table 2, SEM shows the effect of R&D Expenditure on firm performance as mediated by capital structure. The result displays that R&D expenditure has a negative significant impact on a firm's performance:

ROA → (p= 0.017, β=-0.021)
ROE → (p=0.014, β=-0.05)
ROCE → (p=0.019, β=-0.789)

Notably, the outcomes also display that the capital structure and size of the firm expose negative significant impact on firm performance.

Table 2. Structural Equation Modelling Results for Direct Effect between Variables (X on Y with Mediating Variable)

Models	Coefficients	95% Cons.	Interval	T	P
				Statistics	Values
Direct Effect (N=605)					
RDI → ROA	-0.021	-0.317	0.36	0.12	0.017**
DR → ROA	-10.01	-12.07	-7.96	-9.56	0.000***
SIZE → ROA	-1.214	-1.614	-0.815	-5.96	0.000***
RDI → ROE	-0.5	-1.104	0.102	-1.63	0.014**
DR → ROE	-12.16	-16.2	-8.12	-5.9	0.000***
SIZE → ROE	-3.576	-4.515	-2638	-7.47	0.000***
RDI → ROCE	-0.789	1.6738	2.261	-2.35	0.019**
DR → ROCE	-18.89	-23.27	-14.51	-8.46	0.000***
SIZE → ROCE	-4.551	-5.702	-3.4	-7.75	0.000***

N o t e : ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

S o u r c e : authors' own evaluation.

Table 3. Descriptive Statistics and Multicollinearity Test

Panel I Descriptive Statistics						Panel II VIF	
VARIABLE	OBSERVATION	MEAN	STANDARD DEVIATION	MIN	MAX	VIF	1/VIF
ROA	605	12.12	9.88	-23.4	73.94		
ROE	605	22.05	20.11	-37.2	131.8		
ROCE	605	27.43	25.39	-31.5	177.26		
RDI	605	1.96	3.68	0	44.79	1.17	0.8519
SIZE	605	9.91	1.4	5.79	13.79	1.16	0.8599
DR	605	0.26	0.39	0	3.1	1.01	0.989
						VIF MEAN	1.12

S o u r c e : authors' own evaluation.

Table 3 shows summary statistics of the dependent and independent variables in this study. Panel 1 represents descriptive statistics, and panel 2 describes the variance inflation factor (VIF). ROA varies between -23.44 to 73.94, and the mean value is 12.12. Similarly, the minimum value of ROE is -37.23, and the maximum is 131.8 with a mean of 22.05. The average value of ROCE is 27.43, standard deviation is 25.39. Firm size and capital structure have average values of 9.91 and 0.26, respectively. RDI varies between 0 and 44.79, and the average value is 1.96, which indicates that RDI is low.

Panel 2 represents the variance inflation factor of the independent variables. VIF value more than 10 indicates multicollinearity and value lower than 10 that confirms that there is no multicollinearity existing between variables. Here, the average VIF value is 1.12, showing that independent variables are free from multicollinearity.

Table 4. Person Correlation Coefficient

	ROA	ROE	ROCE	RDI	SIZE	DR
ROA	1					
ROE	0.6461	1				
ROCE	0.5021	0.4685	1			
RDI	0.0565	-0.0569	-0.0736	1		
SIZE	-0.461	-0.32	-0.3728	-0.1044	1	
DR	-0.3215	-0.335	-0.3564	-0.0412	0.3743	1

S o u r c e : authors' own evaluation.

Table 4 represents correlation between variables. Here, overall profitability and R&D Index are not highly correlated as their values less than 0.7. Also, other variables such as capital structure and firm size are not highly correlated with profitability.

Static Panel Estimation

Table 5. The Relationship Between RDI and Firm Performance (Dependent: ROA)

Variable	Pooled-OLS	FIXED effect	Random Effect	Hausman	Lagrangian	Acceptance
RDI	0.201539	-0.4434053	-0.3745629			
	(0.823)	(0.000)***	(0.000)***			
DR	-10.01611	-5.642402	-6.452069			
	(0.000)***	(0.000)***	(0.000)***	0.0274**	0.000***	FEM is accepted.
SIZE	-1.214997	-0.4209779	-0.78002			
	(0.000)***	(0.331)	(0.038)**			
CONSTANT	26.83117	18.69439	22.33692			
	(0.000)***	(0.000)***	(0.000)***			

N o t e : ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

S o u r c e : authors' own evaluation.

In table 5, the analysis reveals a significant positive relationship between RDI and ROA across all models. The Breusch-Pagan Lagrange Multiplier (BPLM) test, with a p-value of 0.000 (significant at 1%), rejects the null hypothesis, favoring the Random Effects Model (REM) over OLS. However, the Hausman test, with a p-value of 0.0274 (significant at 5%), rejects the null, confirming the Fixed Effects Model (FEM) as the most appropriate for reliably assessing RDI's impact on ROA. The result exhibits that RDI has a significant negative relationship (-0.443, p=0.000), DR shows a significant negative relationship (-5.642, p=0.000), while SIZE is not significant (p=0.331).

Table 6. The Relationship between RDI and Firm Performance (Dependent: ROE)

Variable	Pooled-OLS	FIXED effect	Random Effect	Hausman	Lagrangian	Acceptance
RDI	-0.5007489	-0.826252	-0.7757926			
	(0.015)**	(0.001)***	(0.001)***			
DR	-12.16371	-6.241161	-6.974726			
	(0.000)***	(0.009)***	(0.002)***			
SIZE	-3.576714	-4.700098	-4.564518	0.6026	0.000***	REM is accepted.
	(0.000)***	(0.000)***	(0.000)***			
CONSTANT	61.78018	71.96103	70.71538			
	(0.000)***	(0.000)***	(0.000)***			

N o t e : ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

S o u r c e : authors' own evaluation.

Table 6 shows that the Hausman test is 0.6026, and the null hypothesis is accepted. Therefore, the REM is more appropriate. Thereafter, the Breusch-Pagan Lagrange multiplier (BPLM) test is applied to select between OLS and REM. The results show the BPLM test is significant (p=0.000) at the 5% level, rejecting the null hypothesis in favor of the alternative. Finally, in this table, REM is most appropriate to test the effectiveness of R&D Index with ROE. RDI exhibits a significant negative relationship (-0.776, p=0.001), DR shows a significant negative relationship (-6.975, p=0.002), and SIZE displays a significant negative relationship (-4.565, p=0.000).

Table 7. The Relationship Between RDI and Firm Performance (Dependent: ROCE)

Variable	Pooled-OLS	FIXED effect	Random Effect	Hausman	Lagrangian	Acceptance
RDI	-0.7870464	-0.7790593	-0.7773397			
	(0.002)***	(0.007)***	(0.004)***			
DR	18.89629	-12.45303	-13.239			
	(0.000)***	(0.000)***	(0.000)***			

Table 7. The Relationship...

Variable	Pooled-OLS	FIXED effect	Random Effect	Hausman	Lagrangian	Acceptance
SIZE	-4.551262	-5.436852	-5.376258	0.8118	0.000***	REM is accepted.
	(0.000)***	(0.000)***	(0.000)***			
CONSTANT	79.20336	86.22997	85.83781			
	(0.000)***	(0.000)***	(0.000)***			

N o t e : ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

S o u r c e : authors' own evaluation.

Table 7 shows that the Hausman test is 0.8118, and the null hypothesis is accepted. Therefore, the REM is more appropriate. Thereafter, the Breusch-Pagan Lagrange multiplier (BPLM) test is applied to select between OLS and REM. The result shows that the BPLM Test is significant (0.000) at the 1% level of significance and accepts the alternative hypothesis. Finally, in this table, REM is most appropriate to test the effectiveness of R&D Index with ROCE. RDI exhibits a significant negative relationship with ROCE (-0.777, p=0.004), DR shows a significant negative relationship (-13.239, p=0.000), and SIZE displays a significant negative relationship (-5.376, p=0.000).

Dynamic Panel Estimation

Under static panel estimation, endogeneity problem is uncovered and the result cannot be robust. To confront this problem, the authors have applied the Arellano and Bond Dynamic Panel Regression Model (GMM Model) (1991). Firstly, to find out the impact of R&D with firm performances, namely ROA, ROE and ROCE, we developed three models. RDI is considered independent and ROA, ROE and ROCE dependent variables. Secondly, a significant relationship is required between mediating variable and independent variables, and for this, we developed the fourth model, which describes the relationship between R&D and capital structure. Finally, we have regressed the dependent variables with the independent variable and the mediating variable, and the capital structure must affect the firm's performance.

Table 8. The Relationship Between R&D Index and Firm Performance

	Model 1	Model 2	Model 3
	(ROA)	(ROE)	(ROCE)
RDI	-0.7344	-1.205	-1.298
	(0.000)***	(0.001)***	(0.001)***
SIZE	1.38	2.769	3.477
	(0.469)	(0.613)	(0.621)
CONSTANT	-3.773	-18.072	-27.289
	(0.833)	(0.746)	(0.702)
WALD TEST	49.07 (0.003)***	55.54 (0.000)***	175.51 (0.008)***
AR (1)	-2.13 (0.000)***	-3.24 (0.000)***	-2.77 (0.000)***
AR (2)	1.15 (0.765)	1.79 (0.869)	1.24 (0.627)
SARGAN TEST	45.19 (1.000)	45.03 (1.000)	51.67 (1.000)
OBSERVATION	495	495	495

N o t e : ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

S o u r c e : authors' own evaluation.

The study applies the System GMM method by Arellano and Bover (1995) and Blundell and Bond (1998), as shown in table 8. Specifically, RDI coefficients are -0.7344 (p=0.000) for ROA (Model 1), -1.205 (p=0.001) for ROE (Model 2), and -1.298 (p=0.001) for ROCE (Model 3), all at 1% significance. Control variable SIZE remains insignificant (p>0.46) across specifications.

Post-estimation diagnostics validate the model specification. Insignificant Sargan test results confirm no over-identification issues and valid instruments. Likewise, the non-significant AR(2) statistic rules out second-order autocorrelation, ensuring robust and reliable findings.

Table 9. Capital Structure, R&D Index, and Firm Performance

	Model 4	Model 5	Model 6	Model 7
	(DR)	(ROA)	(ROE)	(ROCE)
RDI	-0.001	-0.782	-1.265	-1.362
	(0.541)	(0.000)***	(0.001)***	(0.000)***
SIZE	-0.0058	1.085	2.23	2.941
	(0.872)	(0.566)	(0.044)**	(0.034)**
DR		-7.584	-14.853	-23.132
		(0.004)***	(0.671)	(0.034)**
CONSTANT	0.2037	1.472	118.2	18.329
	-0.564	-0.934	-0.864	-0.795
WALD TEST	18.19 (0.000)***	67.76 (0.006)***	74.11 (0.000)***	160.19 (0.000)***
AR (1)	-2.2 (0.0251)**	-2.02 (0.008)***	-3.237 (0.003)***	-2.64 (0.023)**
AR (2)	-1.23 (0.863)	1.17 (0.153)	1.87 (0.694)	1.25 (0.796)
SARGAN TEST	45.94 (1.000)	44.5 (1.000)	48.4 (1.000)	48.84 (1.000)
OBSERVATION	495	495	495	495

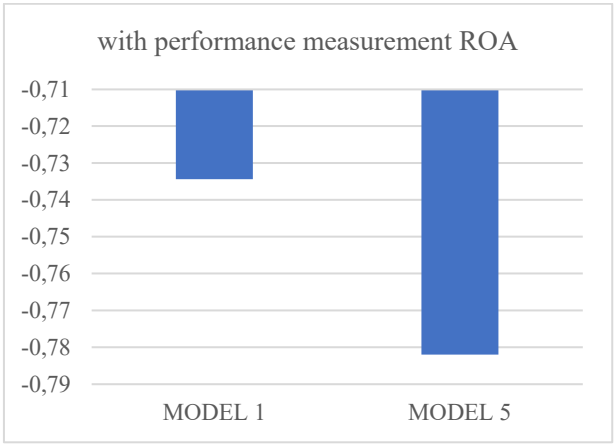
N o t e : ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

S o u r c e : authors' own evaluation.

Table 9 represents the mediation effect of capital structure with R&D Index and firm performances. RDI consistently shows significant negative effects on performance: -0.782 (ROA), -1.265 (ROE), -1.362 (ROCE). DR reveals negative significance for ROA (-7.584) and ROCE (-23.132), but insignificant for ROE. SIZE gains significance in ROE (2.23) and ROCE (2.941).

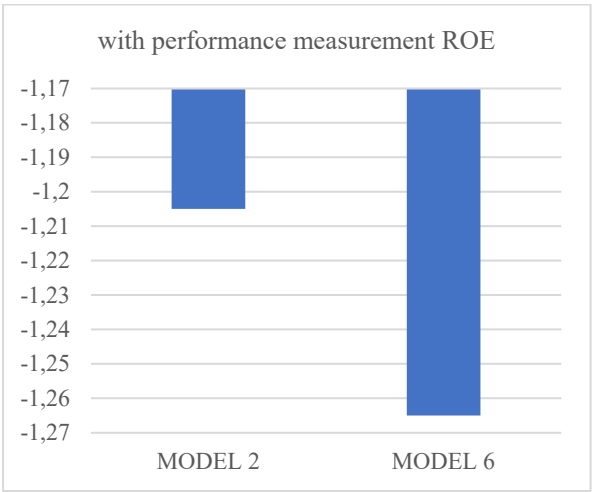
The Sargan test shows no issues (not significant), meaning the instruments are valid and there is no over-identification problem. The AR(2) test also shows no second-order autocorrelation (not significant), so the results are reliable.

Figure 3. ROA–RDI Relationship Mediated by Capital Structure



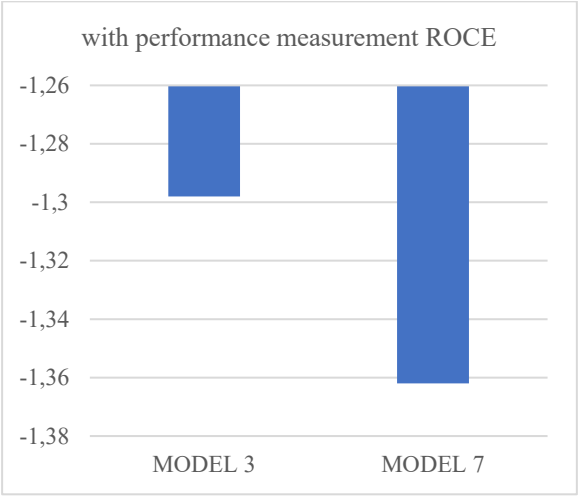
S o u r c e : designed by the authors.

Figure 4. ROE–RDI Relationship Mediated by Capital Structure



S o u r c e : designed by the authors.

Figure 5. ROCE–RDI Relationship Mediated by Capital Structure



S o u r c e : designed by the authors.

Figure 3 represents the direct relationship between ROA and RDI and its mediation effect of capital structure. The graph reveals R&D Index negatively affect the return on asset. However, with the presence of mediating factor, it affects more significantly. Similarly, figures 4 and 5 reveal the negative relationship with firm performance between ROE and ROCE.

Conclusion

This study investigates the relationship between research and development (R&D) intensity and firm performance, with particular emphasis on the mediating role of capital structure, using a balanced panel of 55 BSE-listed companies over the period 2014–15 to 2023–24. Employing fixed effects, random effects, and System GMM estimations, the study provides robust empirical evidence on the R&D–performance nexus in the Indian context.

The results consistently indicate a statistically significant negative association between R&D intensity and firm performance, as measured by return on assets (ROA), return on equity (ROE), and return on capital employed (ROCE).

These findings suggest that increased R&D expenditure does not translate into immediate financial performance gains for Indian listed firms. The negative coefficients may be attributed to longer gestation periods of R&D investments, high adjustment and financing costs, and inefficiencies in the commercialization of innovation outcomes.

Furthermore, the mediation analysis confirms that capital structure plays a significant mediating role in the relationship between R&D intensity and firm performance. The debt–equity ratio exhibits a negative and significant effect on firm performance, particularly for ROA and ROCE, indicating that higher leverage exacerbates the adverse impact of R&D investments on firm performance. Diagnostic tests, including the Sargan and AR(2) tests, confirm the validity of instruments and the absence of second-order autocorrelation, thereby supporting the reliability of the empirical results.

Overall, the study fails to support the hypothesis of a positive impact of R&D expenditure on firm performance, while providing partial support for the mediating role of capital structure. The findings contribute to the existing literature by highlighting the importance of financing decisions in determining the effectiveness of R&D investments in emerging markets.

Limitations of the Study

While the study provides robust empirical evidence on the R&D–performance relationship, there are certain limitations. R&D intensity is measured using accounting-based expenditure data, which may not fully reflect qualitative innovation outcomes. The analysis focuses on contemporaneous relationships, and future research may further explore potential lagged effects. Additionally, capital structure is examined as a mediating variable, while other influencing factors are left for subsequent studies.

Recommendations of the Study

Firms should carefully plan and monitor their R&D investments so that these activities are aligned with business goals and lead to practical and commercially viable outcomes.

As capital structure influences the impact of R&D on performance, firms should avoid excessive use of debt to finance R&D activities and adopt a balanced financing approach.

Policymakers can support firms by providing appropriate incentives and facilitating access to equity-based funding, thereby reducing the financial pressure associated with R&D investments.

Directions for Future Research

Future research may extend the present study in several ways. First, incorporating lag structures may provide deeper insights into the long-term effects of R&D investments on firm performance. Second, the use of market-based performance measures, such as Tobin's Q or stock returns, could complement accounting-based indicators. Third, future studies may explore additional mediating or moderating variables, including corporate governance, ownership structure, and industry characteristics. Finally, comparative analyses across emerging and developed markets could further enrich understanding of the R&D–performance relationship.

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