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The Linkage between Corporate Research and Development Intensity and Stock Returns: Empirical Evidence

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Abstract: Research and development (R&D) is a significant driver of innovation that leads to superior performance. The present study attempts to examine the relationship between R&D intensity and a firm's performance at both aggregate and industry levels in the emerging market of India using a battery of R&D intensity measures and stock market returns as a measure of a firm's performance. The study was conducted on 1097 companies from six R&D-intensive industries. The Fama-French portfolio formation method was used to evaluate the stock market performance of R&D-intensive firms for both equal-weighted (EW) and value-weighted (VW) returns. The findings suggest that R&D intensity and stock returns show a positive relationship. A long–short strategy in R&D-intense firms has yielded 1.43% (t = 4.22) per month in the sample. In general, the results suggest an undervaluation of highly R&D-intensive firms that investors can exploit for above-average returns. The effect is not homogeneous across return schemes (equal-weighted and value-weighted) or across industries. R&D growth measures and R&D capital are not found to have significant impacts on stock returns. Both the market firm size and age are included as control variables, and the results reveal that the relationship is robust to these control variables. The sub-periods ranging from 2000 to 2007 and 2008 to 2019 have been considered in the present study and the results are consistent with the overall sample. The study fills the existing empirical void for R&D intensity and stock returns in relation to the emerging market of India.

Keywords: research and development; R&D intensity; stock returns; intangibles; India

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1. Introduction

Investment is requisite to the functioning of an economy. The task of devoting resources, time, and money to produce valuable outputs in the future is crucial to businesses, governments, and individuals. Over the last few decades, a significant change has taken place; intangible investment has risen inexorably in the form of new ideas, knowledge, aesthetic content, software, brands, networks, and relationships (Haskel and Westlake 2017). The market value of firms depends on these crucial intangibles as much as it depends on tangible assets. However, accounting regulations still treat these value-creating intangible investments as regular expenses like salaries, rent, and interest (Lev and Gu 2016). Let us contemplate an accounting inanity: prominent value generators of contemporary enterprises, such as research and development, brands, and information technology, are regarded as interest or salary expenses devoid of prospective benefits. Conversely, the 'commoditised' tangible (fixed) assets, which generate negligible value because they are accessible to all competitors, are capitalised. Therefore, firms that make business R&D (research and development) expenditures do not signal any value creation in the form of higher earnings in the short run (Lev and Gu 2016; Kim et al. 2018; Chen et al. 2020; Lev 2019; Kim and Park 2020; Alam et al. 2019; Arif Khan et al. 2023).

On the other hand, firms with minimal investment in intangibles report higher earnings. Investors are attracted more to tangible information than less tangible information. "Tangible" information refers to data, such as earnings reports, that can be easily analysed using quantitative methods. By analysing historical data, investors can have a high level of confidence in predicting future profit returns. Our framework differentiates between tangible data, like dividends, which can be analysed using econometric methods, and intangible information, like news headlines, which is difficult to measure but nevertheless influential in the decisions made by market participants. Daniel and Titman (2006) posits that intangible information is inherently ambiguous, whereas tangible information is unambiguous. Similarly, investors devote less attention to the data, which is arduous (Corwin and Coughenour 2008; Schwarz et al. 2010). Some authors (e.g., Porter 1992; Hall 1993; Hall et al. 1993) advocate that investors have short time horizons, so they are unable to foresee the rewards from investments for the future, such as R&D, software, design, market research, and branding, etc., that create strategic options for firms (Barber and Odean 2008). These factors may induce under-pricing of firms that invest in intangible assets. R&D expenditure, an investment in intangible assets can result in positive future cash flows; therefore, high R&D intensity firms may provide higher stock market returns than lower R&D intensity firms. Companies that allocate significant resources to research and development (R&D) consistently demonstrate positive abnormal returns, suggesting that R&D expenditure is a reliable explanatory factor for stock returns. Recent studies have discovered that investing in research and development (R&D) consistently and significantly affects stock values over extended periods of time. Investing in research and development (R&D) is a crucial means for companies to enhance their value by effectively communicating with the stock market (Kim and Park 2020; Hou et al. 2022).

While some research reveals that R&D is a significant driver of firm innovation and ultimately future firm performance (Bowen et al. 2010), other studies show that R&D expenditures are risky and do not always result in better firm performance, especially when firms fail to satisfy market needs (Liao and Rice 2010). The contrasting effect of R&D expenditure on firm performance is contingent upon many factors, including the institutional environment (Peng 2002), firm age (Rafiq et al. 2016), type of ownership (Ruiqi et al. 2017), product market competition (Yung and Nguyen 2020), financial constraints (Li 2011), corporate governance (Chan et al. 2015), and performance measures (Felix Ayadi et al. 1996).

In this paper, the relationship between R&D and firm performance is examined following the portfolio formation method of Fama and French (1993) in a sample of R&D-intensive Indian firms. This study tries to validate the hypothesis of the existing literature that that high R&D-intensive stocks are associated with higher future stock returns (Chan et al. 2001; Eberhart et al. 2004; Li 2011; Ruiqi et al. 2017; Lundmark 2021) In addition to this, industry affiliation may also affect the R&D–performance relationship as industries differ in their characteristics (Porter 1997). Therefore, in the present study, the matter of whether the effect of R&D intensity on stock returns is homogeneous across industries is also probed, an unexplored area in the Indian context.

There is a dearth of literature focusing on the R&D–stock return relationship in the Indian context. The absence of any study focusing on this relationship gave impetus to the present study. Existing studies in India have focused on R&D and Tobin's Q, ROA, or ROE relationship as a metric of firm performance. To the best of the authors' knowledge, the present study is the first to focus on the relationship between R&D and stock returns. Moreover, industry-wise heterogeneity has also been taken into consideration, which is also an unexplored area in the existing studies of India.

The study findings suggest that R&D intensity and stock returns are positively related. A long–short strategy in R&D intensity-based firms has yielded 1.43% (t = 4.22) per month in the study sample. This performance is mainly driven by the long leg of the strategy (2.49%, t = 3.01 per month) and suggests that the market compensates for the additional risk associated with the R&D investment. Further, the analysis also reveals that, on average, R&D-active firms do not outperform R&D-inactive firms, suggesting that it is not

R&D activity per se but rather R&D intensity that has predictive value for future returns. This systematic undervaluation of R&D-intensive firms may provide superior returns to investors. Finally, industry-wise results reveal that the positive impact of R&D intensity is not homogeneous and varies across industries.

The present study contributes to the literature in the following ways: Firstly, and most crucially, it examines the R&D intensity–stock returns relationship, an unexplored area in the Indian context, as existing studies only deal with accounting-based measures such as ROE and ROA (Pramod et al. 2012; Jaisinghani 2016; Pal and Nandy 2019; Sinha et al. 2019) and market-based measures such as Tobin's Q (Pramod et al. 2012) as a measure of a firm's performance. Fama-French and Carhart's portfolio formation technique has been applied, revealing that high R&D-intensive portfolios yield higher future stock returns, and R&D intensity is the main predictor of future stock returns as opposed to R&D activity. Past studies in India have applied various models such as the Tobit model (Ghosh 2009; Tyagi et al. 2018), OLS, the fixed-effect model (Pramod et al. 2012; Tyagi et al. 2018; Pal and Nandy 2019; Sinha et al. 2019), and the random-effect model (Jaisinghani 2016; Tyagi et al. 2018; Pal and Nandy 2019; Sinha et al. 2019) to study relationships between R&D and firm performance. To date, this is the first study that has applied the Fama-French and Carhart portfolio formation techniques to study the R&D–stock return relationship in India.

Secondly, this study fills the empirical void for industry-wise heterogeneity as the prevailing studies have focused on just a few industries, namely, the electrical and electronics industry (Pramod et al. 2012; Jaisinghani 2016), the drugs and pharmaceuticals industry (Chatterjee 2007; Sharma 2012; Jaisinghani 2016; Tyagi et al. 2018; Pal and Nandy 2019), and automobiles (Jaisinghani 2016), with limited sample firms. The present study tries to find industry-wise heterogeneity by focusing on six major R&D-intensive industries, namely, chemicals, computer and software services, drugs and pharmaceuticals, electricals, textiles, and transportation, including 1097 firms. The study shows that the R&D–stock returns relationship is not homogeneous across industries and significant differences exist.

Thirdly, a battery of R&D-related metrics were examined that included four R&D intensities; R&D relative to market value, book value, net profit, and sales; two measures of R&D growth or change; the absolute amount of R&D expenditure; and R&D capital. The results show that it is mainly the R&D intensity relative to market value that drives the positive relationship between R&D and stock returns; R&D expenditure, R&D change, and R&D capital are insignificant in the sample. The past studies in the Indian context have examined the impact of R&D intensity on firm performance using only one of the measures of R&D intensity, for example, R&D expenditure relative to sales (Ghosh 2009; Pramod et al. 2012; Sharma 2012; Jaisinghani 2016; Tyagi et al. 2018 Pal and Nandy 2019) or R&D expenditure relative to market value (Pramod et al. 2012).

Fourthly, both market size and age have been included for firms as control variables, and the results reveal that the relationship is robust to these control variables. Finally, a sub-period analysis was also conducted and the results came out to be consistent with the overall sample. Therefore, the present study differs from the past studies in terms of the different types of R&D intensities measured, industry-wise segregation, the methodology applied, sample size, and sample period.

The rest of the paper is organized as follows: a brief literature review is contained in Section 2. Section 3 describes the methodology, Section 4 presents the results and Section 5 concludes the paper.

2. Literature Review

The resource-based view explains that the success of a firm depends on the valuable, rare, inimitable, and organized (VRIO) resources in order to attain a competitive advantage and superior firm performance. Innovation is essential to attain a sustainable competitive advantage. R&D investment is a key driver of innovation that results in a competitive advantage and superior firm performance in the form of new products or new processes and improved quality.

In a resource-based view, organizational success hinges on the valuable, rare, inimitable, and organized (VRIO) resources that ultimately result in a competitive advantage and superior firm performance (Barney 1991). Innovations are one key route through which a firm attains and sustains such a competitive advantage (Chauvin and Hirschey 1993; Gartrell 1990; Yeh et al. 2010). Firms attempt to innovate through investments in R&D activities in order to achieve a competitive advantage and superior economic performance. R&D investments lead to innovations in the form of new products or new processes and quality improvement. However, to do so, the firm compromises its immediate earnings performance mainly because of accounting standards that limit the capitalization of R&D expenses. Contrary to this, many firms may engage in corporate myopia by not engaging in long-term R&D investments. If the resource-based view of the firms holds, then higher R&D investments should lead to superior long-term economic performance relative to firms that do not invest in R&D activities.

In light of the above findings, the extant literature has been examined to establish the impacts of R&D on different metrics of firm performance. In general, studies that have focused on accounting ratios-based performance measures such as ROA and ROE have reported a negative relationship between R&D and performance (Felix Ayadi et al. 1996; Cazavan-Jeny et al. 2011). This could be due to the expensing of R&D that negatively influences earnings-based measures, as indicated by Lev and Gu (2016). On the other hand, other studies that have taken market-based measures such as Tobin's Q as a performance proxy have found a positive R&D–performance relationship (Chan et al. 2001; Bae and Kim 2003; Connolly and Hirschey 2005; Li 2011; Chen et al. 2019b). Studies that have examined the relationship between R&D intensity and stock returns specifically as performance measures have found that a high R&D expenditure is associated with higher stock returns (Chan et al. 2001; Eberhart et al. 2004; Ciftci et al. 2011). Songur and Heavilin (2017) reported that an abnormal increase in R&D expenditure leads to higher returns. Using a non-linear model, Chen et al. (2019b) found that beyond a threshold level, high R&D-intensive firms underperform low R&D-intensive firms. In the Indonesian market, Safitri et al. (2020) investigated the association between R&D, firm value, and eco-efficiency. The research results demonstrate that R&D positively impacts firm performance. Kim and Park (2020) documented that higher R&D portfolios earn consistently higher abnormal returns. Ravšelj and Aristovnik (2020) conducted a study on the influence of research and development (R&D) expenditures on the performance of companies in both the Slovenian and global economies. The empirical findings indicate that R&D spending do not yield immediate returns but do offer certain advantages in the long run. Hou et al. 2022 discovered positive correlations between R&D intensity and future operating performance, return volatility, and default likelihood. The study's findings indicate that the relationship between R&D intensity and stock returns is more likely due to the risk premium rather than mispricing.

The evidence, primarily centred on developed countries, has shown that R&D intensity and stock returns have a positive relationship. There is a wide range from the USA (Hall et al. 1993; Lev and Sougiannis 1996; Lev 1999; Aboody and Lev 2000; Chan et al. 2001; Chan et al. 2015; Chen et al. 2019a; Ahmed et al. 2023), to the U.K. (Al-Horani et al. 2003; Dedman et al. 2009; Lundmark 2021), Japan (Nguyen et al. 2010), and South Korea (Kim and Park 2020). In emerging markets like Turkey (Başgoze and Sayin 2013), Pakistan (Ghaffar and Khan 2014), and China (Lu 2020), a positive relationship between R&D and market value has also been reported.

In the context of India, there is a dearth of detailed studies related to R&D and firm performance; however, a few studies in India have examined the association between R&D and firm performance (Sharma 2012; Chatterjee 2007; Pramod et al. 2012). Chatterjee (2007) reported that the market values R&D activity positively, wherein more recent R&D activity matters more, as observed for a sample of Indian pharmaceutical firms by conducting pooled regression of Tobin's Q from 1990 to 2005. Sharma (2012) investigated the link between R&D and Total Factor Productivity (TFP) in a sample of Indian pharmaceutical companies and reported a positive association between them from 1994 to 2006. Pramod et al. (2012) reported a positive curvilinear relationship between R&D intensity and Tobin's Q on a sample of Indian manufacturing firms.

Jaisinghani (2016) studied two categories of firms, independent (stand-alone) and business groups, including three industries, namely, automobiles, electronics, and pharmaceuticals industries. Using panel data analysis, the study reports that group firms perform less efficiently compared to independent firms as they overspend on R&D activities, and business firms should, therefore, reconsider their R&D strategy in order to improve profitability. Tyagi et al. (2018) applied a random-effects panel Tobit model to the top 91 domestic firms in the Indian drugs and pharmaceuticals industry to investigate factors explaining R&D intensity. The results reveal that import, export, and past year profit positively affect R&D activity, whereas firm size affects it negatively. Pal and Nandy (2019) also investigated the relationship between innovation and business sustainability for a sample of 37 Indian pharmaceutical firms and found a positive relationship between innovation through R&D activities and measures of firm performance, which in turn ensure business sustainability. Sinha et al. (2019) analysed the relationship between R&D and total income and found a significant result. In their recent study, Kumari and Mishra (2021) investigated the relationship between the intangible intensity of a company and the valuation of equity in India based on research and development (R&D) information. Based on the relevance of R&D information to ascertain equity values in India during the 25-year study period (from 1991 to 2016), the results indicate that the intangible intensity of the firm moderates the relationship significantly. Manogna and Mishra (2021) examined the relationship between the intensity of research and development (R&D) and the performance of a company, as measured by sales growth in an emerging market such as India. The results of the study indicate that innovation investments positively impact the expansion of companies operating in the food and agricultural manufacturing sector of India. Further examination demonstrates that newer companies experience more rapid growth when they allocate resources towards research and development.

This study contributes to the literature by investigating the relationship between a battery of R&D intensity measures and stock returns by following the portfolio formation methodology of Fama and French (1993) in the Indian context, a currently unexplored area. Moreover, the paper examines six R&D-intensive sectors to study the industry-wise heterogeneity. To the best of the authors' knowledge, this study provides new evidence on the relationship between R&D intensity and stock return as a performance measure in the Indian context.

3. Data and Methods

3.1. Data

The data on stock market variables and company accounting items are obtained from Prowess I.Q., a database maintained by the Centre for Monitoring Indian Economy (CMIE), from July 2000 to February 2019. A total of six R&D-intensive industries were chosen for this study, i.e., chemicals, computer programming and software services, drugs and pharmaceuticals, electrical, textiles, and transportation. All these industries are considered R&D-intensive in the prior literature (for example, Chan et al. 2001). After accounting for missing values and truncation of the data, 1097 firms listed in National Stock Exchange (NSE) belonging to these industries were selected for the analysis. The number of companies in each sector was as follows: chemicals 148; computer programming and software services 187; drugs and pharmaceuticals 149; electrical 194; textiles 237; and transportation 182.

3.2. Methods

The analysis was performed at both the aggregate and industry levels to examine the R&D intensity–stock return relationship. Therefore, the present study deals with both an industry-wise and aggregate sample of 1097 companies. By allocating the sample companies into five portfolios of equal size by the end of June in year t, we arrange them according to their R&D intensity measures in year $t-1$. Monthly data are used to construct portfolios. The low quintile consists of the twentieth percentile of companies with the least amount of R&D intensity, while the high quintile consists of the twentieth percentile of companies with the most R&D intensity. Following that, we calculate the returns of each portfolio using both value-weighted and equal-weighted methodologies for each month beginning in July of year t and ending in June of year $t + 1$. Regressions of the following form were estimated to evaluate the risk-adjusted performance of the portfolios:

$$R_p = \alpha + \beta_1(R_m - rf) + \beta_2 SMB + \beta_3 HML + \beta_4 WML + \varepsilon \quad (1)$$

The following variables are considered in the formula: R_p denotes the average raw returns produced by a long position in a market portfolio that is equally weighted and stocks with a positive RDI during calendar month t; rf represents the return on one-month T-bills; R_m signifies the return on the value-weighted market index; *SMB* signifies the return on a portfolio of small stocks minus the return on a portfolio of large stocks; and *HML* signifies the return on a portfolio of stocks with high book-to-market ratios minus the return on a portfolio of low book-to-market stocks.

Thirdly, as an additional risk factor, we estimate abnormal stock returns using a momentum factor (*WML*; return on high momentum stocks − return on low momentum stocks). Subsequently, the Fama-French three-factor model is renamed the Carhart four-factor model.

The estimated intercept, also known as alpha, in the model represents the abnormal returns, or risk-adjusted returns, on our RDI-ranked portfolios.

The data for Carhart's four factors are obtained from the data library of Agarwalla et al. (2014), (https://faculty.iima.ac.in/~iffm/Indian-Fama-French-Momentum, accessed on 3 March 2020).

Following Chan et al. (2001) and Lev and Gu (2016), among others, R&D intensity (RDI) was measured as the ratio between R&D expenditure to market value/book value/sales/profit of the firm. For the sake of brevity, only the detailed results of R&D intensity relative to market value are presented. In addition to a bivariate classification by organisation age and size, the analysis of industries and sub-periods has incorporated R&D intensity in relation to market value. The results of other measures of R&D intensity, however, were found to be weak in this analysis (mentioned in Table 5). Table 1 displays the year-wise (Panel A) and industry-wise average R&D intensities (Panel B). The average R&D intensities are 2.54%, 2.37%, 1.90%, and 27.4% relative to the market value, book value, sales, and profits, respectively. The average R&D intensity of R&D-active firms relative to the market value was 2.13% and 1.27% in 2000 and 2018, respectively. Panel B exhibits the average values of intensities of R&D-active firms. The average values show that the computer programming and software services industry is the most R&D-intensive industry but lags behind in terms of the number of firms involved in R&D activities. The drugs and pharmaceuticals industry has the greatest number of R&D-active firms (64), with a 2.81% RDI. This conforms with Chan et al.'s (2001) findings that drugs and pharmaceuticals rank second to the computer programming and software services industry in terms of R&D intensity in the U.S. market. This is followed by the electrical, transportation, and textiles industries. As a profit percentage, R&D intensity varies from 13.32% to 48.80%.

Panel B of Table 1 mentions the number of firms on an average in each industry having positive R&D (i.e., firms that are involved in R&D expenditures). The table shows a total of 291 firms are actively involved in performing R&D expenditure. During 2000–2019, chemicals (59 firms), computer and software (17 firms), drugs and pharmaceuticals (64 firms), electrical (57 firms), textiles (33 firms) and transportation (61 firms) industries actively spent on R&D.

Portfolios are compiled monthly, spanning from July 2000 to February 2019. The number of monthly observations in each portfolio, based on varied intensities, was identical, notably 224.

Table 1. R&D intensity (RDI) by calendar year and industry (in percentage).

Panel A: Annual Distribution of R&D Intensity Measures					
		Average R&D Intensity Relative to			
Year	**Obs.**	**MV**	**BV**	**Sales**	**Profit**
2000	186	2.13	1.16	1.41	82.70
2001	197	3.73	1.81	1.16	42.41
2002	216	3.62	1.87	1.42	20.18
2003	217	4.38	2.30	1.76	18.27
2004	228	2.43	1.57	3.28	19.02
2005	242	1.51	2.05	2.09	12.39
2006	255	1.05	2.90	1.95	25.13
2007	254	1.48	1.80	2.17	12.36
2008	264	1.84	1.65	3.10	10.64
2009	267	3.82	1.83	1.45	50.86
2010	268	1.63	1.74	1.40	33.19
2011	269	2.43	2.03	1.95	40.06
2012	284	3.33	2.53	1.90	25.70
2013	292	4.74	3.61	1.98	21.44
2014	285	4.05	3.74	2.04	20.10
2015	271	1.96	3.31	1.65	26.45
2016	280	1.69	3.79	1.83	15.87
2017	283	1.23	2.75	1.75	18.71
2018	279	1.27	2.69	1.77	25.27
Total	4837	2.54	2.37	1.90	27.41
Panel B: Selected R&D-Intensive Industries					
	R&D -Active Firms	**MV**	**BV**	**Sales**	**Profit**
Chemicals	59	1.75	1.33	0.58	13.32
Computer and Software	17	4.90	2.97	5.54	48.80
Drugs and Pharmaceuticals	64	2.81	4.48	3.13	38.28
Electrical	57	2.02	2.18	1.31	23.89
Textiles	33	1.78	1.16	0.31	14.53
Transportation	61	2.56	2.63	2.08	26.61
Total	291				

Note: The values of R&D intensity relative to the market value, book value, sales, and profit on an annual basis are shown in the table along with industry-wise distribution.

4. Empirical Results

4.1. R&D Intensity and Stock Returns

Table 2 shows the equal-weighted (EW) and value-weighted (VW) average of quintile portfolios formed each year in July by sorting stocks based on RDI. The portfolios are formed in July every year, giving a time lag of three months to allow investors time to incorporate new information in the price. We arrange all sample companies based on their R&D intensity measures in year $t - 1$ and subsequently divide them into five portfolios of equal size at the end of June in year t. Portfolios are constructed on monthly data. The low quintile comprises the bottom 20% of firms with the lowest R&D intensity, whereas the high quintile comprises the top 20% with the highest R&D intensity. Subsequently, for every month starting from July in year t to June in year $t + 1$, we compute the returns of each portfolio using both equal-weighted and value-weighted methods. Portfolio 1 (5) is the portfolio of low (high) R&D intensity firms. As shown in Table 2, the five quintile portfolios (from low to high) provide EW returns of 1.06%, 1.36%, 1.72%, 2.35%, and 2.49% per month. There is a clear uptrend moving from low to high R&D intensity firms. The difference between the low and high RDI intensity portfolios is 1.43%, which is statistically significant at the 5 percent level. A similar uptrend is found for the value-weighted portfolios, and the return difference between low and high RDI portfolios is 1.81% (*t* = 3.37) for value-weighted portfolios. The Carhart (1997) alphas of the RDI-based hedge portfolios are also significant (1.10% (*t* = 3.92) and 1.60% (*t* = 3.55) for EW and VW portfolios, respectively), implying that there exists a significant difference in the alphas of low and high RDI portfolios. The return difference is significant, both on a raw and risk-adjusted basis. Overall, the results in Table 2 strongly support the hypothesis that high R&D-intensive stocks are associated with higher future stock returns for equal- and value-weighted returns. This positive R&D intensity–return relationship aligns with many prior studies in other markets (Chan et al. 2001; Eberhart et al. 2004; Li 2011; Ruiqi et al. 2017), for instance, reported a positive relationship between R&D expenditure and future performance as measured by net income in the Chinese market using OLS regressions.

Table 2. R&D intensity and stock returns.

Portfolio	EW Portfolios		VW Portfolios		
	Excess Return (%)	4-F Alpha	Excess Return (%)	4-F Alpha	Average RDI
1 (Low RDI)	1.06 (1.62)	0.19 (1.05)	1.15 **(2.30)**	0.66 **(2.44)**	0.1
2	1.36 **(2.10)**	0.33 (1.74)	1.87 **(3.61)**	1.04 **(3.64)**	0.4
3	1.72 **(2.19)**	0.51 (1.90)	2.03 **(3.45)**	1.30 **(4.72)**	0.9
4	2.35 **(3.01)**	1.17 **(3.84)**	2.02 **(3.35)**	1.41 **(3.08)**	2.1
5 (High RDI)	2.49 **(3.01)**	1.29 **(4.10)**	2.96 **(4.06)**	2.26 **(5.07)**	7.9
H-L	1.43 **(4.22)**	1.10 **(3.92)**	1.81 **(3.37)**	1.60 **(3.55)**	

Note: Quintile portfolios are formed each year at the beginning of July based on R&D intensity (RDI). Both equal-weighted (EW) and value-weighted (VW) returns are computed for the portfolios. The 4-factor α values of the quintile portfolios are also reported for the portfolios. H-L represents the average difference in return between high and low RDI portfolios. Newey and West's (1987) adjusted *t*-statistics are reported in parentheses. The sample period is from July 2000 to February 2019. Values in parentheses denote *t*-statistics and values in bold represent significance at the 5 percent level or better.

R&D intensity-based portfolio formation excludes firms that do not make any R&D expenditure. Therefore, the portfolio performance of R&D active (firms with non-zero R&D expenditure) and non-active (firms with zero R&D expenditure) was also compared. On average, there were 291 active firms and 806 inactive enterprises between 2000 and 2019, resulting in a ratio of active to non-active firms (industry-wise count in shown in Table 1 Panel B). The results are shown in Table 3. On average, R&D-active firms provide higher returns than the R&D-inactive firms, but the difference between their returns is not statistically significant. Additionally, in the case of value-weighted returns, the returns are identical, and no difference is found. When this finding is viewed in light of the results in Table 2, it indicates that R&D intensity is the main predictor of future returns rather than the R&D activity-based binary classification.

Table 3. Stock returns of R&D-active and -non-active firms.

Portfolio	EW Portfolios		VW Portfolios	
	Excess Return (%)	4-F Alpha	Excess Return (%)	4-F Alpha
R&D active	2.32	0.98	1.40	0.76
	(2.78)	**(3.62)**	**(2.20)**	**(2.95)**
R&D non-active	1.81	0.70	1.40	0.82
	(2.48)	**(3.32)**	**(2.89)**	**(3.90)**
Difference	0.51	0.27	0.00	0.053
	(1.82)	(1.23)	(0.00)	(0.21)

Note: Sample firms are divided into two portfolios based on R&D expenditure. R&D-active firms are those that have a positive value of R&D expenditure and R&D-non-active firms are those that do not spend any amount on R&D. The last column shows the difference between the two. Values in parentheses denote *t*-statistics and values in bold represent significance at 5 percent or better.

4.2. R&D Intensity across Industries

R&D intensity may vary across industries. For instance, Andras and Srinivasan (2003) found that R&D intensity is higher in manufacturing product organizations than in consumer product organizations but is positively related to profit margins in both types of organizations. To examine the heterogeneity of the R&D intensity effect across industries, industry-wise portfolios were formed. Only two portfolios (low and high) were constructed in each sector to ensure a sufficient number of stocks in a portfolio. The results are shown in Table 4 for the six sample industries. The results reveal that the return differences between high and low R&D intensity firms are statistically significant for the chemicals (t = 2.07), drugs and pharmaceuticals (t = 3.58), textiles (t = 2.90), and transportation (t = 3.51) industries. For the textiles and transportation industries, the spreads are significant for both equal-weighted and value-weighted returns. The effect is only present on equal-weighted returns for the chemicals and drugs and pharmaceuticals industries. The effect on equal-weight returns indicates the relationship of this effect to the small-capitalization firms and the pervasiveness of the anomalous effect on small firms is congruent with the earlier findings that anomalies are more likely to persist in the difficult-to-arbitrage smaller firms (Ali et al. 2003; Aziz and Ansari 2017). The return differences in the computer and software and electrical equipment industries are not statistically significant. In general, it can be concluded that the impact of R&D intensity on stock returns is not homogeneous across industries and considerable differences exist across sectors.

Table 4. Industry-wise sorts of R&D intensity.

	EW Portfolios		VW Portfolios		
Portfolios	Excess Return (%)	4-F a	Excess Return (%)	4-F a	Average RDI (MV)
Panel A: Chemical Industry					
Low	1.80	0.52	2.30	1.11	0.30%
	(2.49)	(1.94)	**(3.42)**	**(3.62)**	
High	2.80	1.21	3.20	2.01	3.10%
	(3.01)	**(3.29)**	**(3.40)**	**(4.06)**	
H-L	1.00	0.70	0.80	0.90	-
	(2.08)	(1.84)	(1.37)	(1.71)	

Table 4. *Cont.*

	EW Portfolios		VW Portfolios		
Portfolios	**Excess Return (%)**	**4-F *a***	**Excess Return (%)**	**4-F *a***	**Average RDI (MV)**
Panel B: Computer Programming and Software Services					
Low	1.23	1.02	0.98	0.82	0.25%
	(1.38)	(1.95)	(1.51)	(1.77)	
High	0.89	0.58	0.94	1.00	10.53%
	(0.78)	(0.69)	(0.85)	(1.04)	
H-L	−0.34	−0.44	−0.04	0.18	-
	(−0.51)	(−0.66)	(-0.05)	(0.22)	
Panel C: Drugs and Pharmaceuticals					
Low	1.10	0.05	1.40	0.80	0.70%
	(1.82)	(0.17)	**(3.62)**	**(2.67)**	
High	2.30	1.12	1.80	1.13	4.90%
	(2.88)	**(2.94)**	**(2.80)**	**(2.72)**	
H-L	1.20	1.07	0.40	0.33	-
	(3.58)	**(3.92)**	(0.99)	(0.99)	
Panel D: Electrical Equipment Industry					
Low	1.30	0.25	1.40	0.60	0.60%
	(1.76)	(1.43)	**(2.31)**	(1.87)	
High	1.80	0.68	1.90	0.89	3.80%
	(2.22)	**(2.25)**	**(2.41)**	(1.75)	
H-L	0.60	0.42	0.50	0.28	-
	(1.75)	(1.42)	(1.02)	(0.64)	
Panel E: Textiles Industry					
Low	0.90	−0.10	1.40	0.50	0.40%
	(1.06)	(−0.19)	(1.81)	(1.02)	
High	2.40	1.13	2.80	1.55	3.30%
	(2.39)	(1.68)	**(2.68)**	**(1.96)**	
H-L	1.50	1.24	1.40	0.98	-
	(2.90)	**(2.62)**	**(2.23)**	(1.70)	
Panel F: Transportation Industry					
Low	1.91	0.90	1.58	1.05	0.20%
	(2.01)	**(2.08)**	**(2.89)**	**(3.04)**	
High	3.50	2.27	2.98	2.21	3.10%
	(3.25)	**(2.89)**	**(3.49)**	**(4.66)**	
H-L	1.58	1.36	1.40	1.15	-
	(3.51)	**(3.06)**	**(2.63)**	**(2.72)**	

Note: Two portfolios are formed across six industries based on R&D intensity. Both equal-weighted and value-weighted returns are computed. Values in parentheses denote *t*-statistics and values in bold denote significance at a 5 percent level or better.

4.3. Alternative R&D Intensities and Other Measures

To test the robustness of the positive R&D intensity and stock returns relationship, R&D intensity scaled by the book value of equity (RDE/BV), sales (RDE/sales), and net profit (RDE/net profit) was also computed. RDE denotes R&D expenditures. In addition, the relationship between total R&D expenditure (RDE) and stock returns was also examined. Moreover, two R&D growth-related measures, 1-year growth and change over the average of 3 years, were also computed, and portfolios were formed following Eberhart et al. (2004), who reported that R&D increases lead to superior stock returns. One more measure related to R&D was computed: R&D capital. Following Chan et al. (2001), among others, an approximation of the stock of R&D capital, RDC_{it}, for firm i in year t based on current and past R&D expenditure (RD_{it}) of four years was adopted where:

$$RDC_{it} = RD_{it} + 0.8 * RD_{it-1} + 0.6 * RD_{it-2} + 0.4 * RD_{it-3} + 0.2 * RD_{it-4} \quad (2)$$

Quintile portfolios were formed based on the above R&D-related measures, and the results are reported in Table 5. As for the alternative measures of R&D intensity, R&D intensity relative to book value produced a significant spread for equal-weighted portfolios, and both the raw return difference (0.53%, t = 2.22) and the 4-F alpha of the hedge portfolio (0.69% t = 2.64) are found to be significant. In the case of RDI (profit), the hedge portfolio's alpha is statistically significant (0.88%, t = 2.39) for equal-weighted returns. The spreads are not statistically significant for RDI (sales). In line with previous research (Chan et al. 2001; Hou et al. 2022, the absolute value of R&D expenditure has also been examined to analyse its influence on future stock returns. The sample firms have been arranged according to the magnitude of their R&D expenditure. The spreads in the case of R&D expenditure are significantly negative for value-weighted portfolios, indicating that the positive relationship is mainly driven by the R&D intensity (i.e., R&D expenditure relative to market capitalisation) and not by the absolute amount of R&D expenditure). RDI (M) demonstrates reduced volatility over a period of time and is comparatively less vulnerable to manipulation via innovative accounting techniques. Because of this, the findings imply that the factor responsible for better stock returns is not research and development activities per se but R&D intensity (Chan et al. 2001).

Table 5. Alternative R&D intensity measures and other R&D-related metrics.

	RDI (MV)		**RDI (BV)**		**RDI (Sales)**		**RDI (Profit)**		**RDE**		**RDE Growth 1 Year**		**RDE Growth 3 Year**		**RD Capital**	
	EW	VW	EW	VW	EW	VW	EW	VW	EW	VW	EW	VW	EW	VW	EW	VW
P1	**1.06**	**1.15**	**1.43**	**1.60**	**2.04**	**1.32**	1.56	**1.45**	**2.24**	**2.19**	**1.50**	**1.28**	**1.40**	0.77	**2.69**	**2.37**
P2	**1.36**	**1.87**	**1.75**	**1.83**	**1.85**	**1.52**	1.52	**1.46**	**2.00**	**1.20**	**1.85**	**1.51**	**1.90**	**1.82**	**1.94**	**2.37**
P3	**1.72**	**2.03**	**1.77**	**1.50**	**2.10**	**1.88**	1.47	**1.44**	**1.74**	**1.81**	**1.90**	**1.90**	**1.67**	**1.57**	**1.85**	1.15
P4	**2.35**	**2.02**	**2.06**	**1.68**	**2.44**	**1.85**	**2.00**	**1.80**	**1.65**	**1.85**	**1.73**	**1.47**	**1.89**	**1.49**	**1.55**	**1.88**
P5	**2.49**	**2.96**	**1.95**	**1.61**	**1.64**	**1.35**	**2.16**	**1.60**	**1.31**	**1.34**	**1.70**	**1.46**	**1.51**	0.82	**1.28**	**1.27**
5-1	**1.43** **(4.22)**	**1.81** **(3.37)**	**0.53** **(2.22)**	0.01 (0.05)	−0.40 (−1.00)	0.02 (0.05)	0.60 (1.44)	0.15 (0.34)	−0.92 (−1.82)	**−0.86** **(−1.22)**	0.20 (0.92)	0.18 (0.53)	0.11 (0.43)	0.05 (0.10)	−1.40 (−2.56)	−1.10 (−1.22)
5-1 alpha	**1.10** **(3.92)**	**1.60** **(3.55)**	**0.69** **(2.64)**	−0.03 (−0.09)	−0.17 (−0.44)	0.15 (0.38)	**0.88** **(2.39)**	0.29 (0.65)	0.06 (0.21)	0.11 (0.20)	0.32 (1.59)	0.56 (1.61)	0.38 (1.68)	0.05 (0.09)	−0.51 (−1.48)	−0.15 (−0.23)

Note: Quintile portfolios are formed based on RDI (MV), RDI (BV), RDI (sales), RDI (profit), R&D expenditure (RDE), RDE growth 1 year, R&D growth over a 3year average, and R&D capital. Mean returns of the portfolios, return differences between high and low, and four-factor alphas are reported for the portfolios. Values in bold denote significance at the 5 percent level. EW represents equal-weighted portfolios and VW represent value-weighted portfolios.

The last three columns of Table 5 show the results for two RDI growth-related measures (1 year and 3 years) and R&D capital. The spreads are found to be statistically insignificant for all three measures.

4.4. Organizational Age and Size as Controls

Double-sorted portfolios were also formed for market capitalization and firm age to examine whether the effect is concentrated in low- or young firms. To this end, 2 × 3 portfolios were formed based on market capitalization and firm age. In order to distinguish the impact of research and development (R&D) from the effects of company size and age, we perform two-way portfolio sorting. This sorting is based on market capitalization and R&D intensity to analyse the size effect and on age and R&D intensity to analyse the age effect. The firms have been divided into two equal halves depending on their size and age. Subsequently, three portfolios have been constructed within each of the previously divided halves. Afterwards, all companies within each category of size and age are evaluated based on their R&D intensity in year t − 1 and then categorised into three R&D portfolios at the start of July in year t. There are six portfolios created by the 2-way sorting method, and their returns are estimated from July in year t to June in year t + 1 using both equal- and value-weighted methods. The final column displays the mean of both divisions, accounting for the influence of size and age, in order to verify the outcomes while accounting for these factors. The results are shown in Tables 6 and 7. The average return of low market capitalization portfolios is higher than the high market capitalization portfolios, consistent with the size effect. The monotonic increase in returns from low to high R&D intensity portfolios is present in both the low and high market capitalization portfolios. The return difference between low and high R&D intensity portfolios remains significant in the controlled portfolios, indicating that the R&D effect is independent of the size effect. Table 7 shows the results of the double sorts and portfolios controlled for firm age. The results in Table 7 show that the R&D effect is robust to the control of organizational age as it is present in the controlled portfolios.

Table 6. Bivariate sorting of size and RDIMV) on stock returns.

	Low MC Firms				**High MC Firms**				**Controlled**			
	EW Returns		**VW Returns**		**EW Returns**		**VW Returns**		**EW Returns**		**VW Returns**	
Portfolios	**Excess Return**	**4-F**	**Excess Return**	**4-F**	**Excess Return**	**4-F**	**Excess Return**	**4-F**	**Excess Return**	**4-F**	**Excess Return**	**4-F**
P1	2.85	0.94	4.91	2.78	1.09	0.23	1.23	0.69	1.97	0.58	3.07	1.74
	(3.03)	**(2.43)**	**(4.64)**	**(5.98)**	(1.68)	(1.35)	**(2.45)**	**(2.76)**	**(2.58)**	**(2.51)**	**(4.27)**	**(5.75)**
P2	3.59	1.80	5.57	3.89	1.26	0.33	1.71	0.95	2.42	1.07	3.63	2.42
	(3.77)	**(4.31)**	**(5.35)**	**(6.44)**	(1.79)	(1.50)	**(3.30)**	**(3.47)**	**(3.00)**	**(3.63)**	**(5.14)**	**(6.70)**
P3	3.65	1.84	5.35	3.55	1.89	0.91	2.30	1.61	2.76	1.38	3.82	2.58
	(3.37)	**(3.45)**	**(4.74)**	**(5.70)**	**(2.58)**	**(3.23)**	**(3.65)**	**(3.66)**	**(3.21)**	**(4.00)**	**(4.79)**	**(6.35)**
H-L	0.79	0.91	0.43	0.77	0.79	0.68	1.07	0.92	0.79	0.79	0.75	0.84
	(1.71)	**(2.04)**	(0.80)	(1.39)	**(3.55)**	**(2.83)**	**(2.55)**	**(2.39)**	**(2.93)**	**(3.33)**	**(2.17)**	**(2.63)**

Note: Three portfolios from each low and high MC were formed. The division of low and high MC was performed using the median value of MC. Controlled portfolios were calculated using the average of both low and high values from each portfolio of MC. Values in parentheses denote *t*-statistics and values in bold represent significance at 5 percent or better.

Table 7. Bivariate sorting of age and RDI(MV) on stock returns.

	Young firms				**Mature firms**				**Controlled**			
	EW Returns		**VW Returns**		**EW Returns**		**VW Returns**		**EW Returns**		**VW Returns**	
Portfolios	**Excess Return**	**4-F**	**Excess Return**	**4-F**	**Excess Return**	**4-F**	**Excess Return**	**4-F**	**Excess Return**	**4-F**	**Excess Return**	**4-F**
P1	1.18	0.18	1.04	0.76	1.22	0.30	1.14	0.57	1.19	0.24	1.09	0.66
	(1.52)	(0.69)	(1.79)	**(2.10)**	(1.94)	(1.71)	**(2.33)**	**(2.27)**	(1.73)	(1.31)	**(2.16)**	**(2.69)**
P2	1.71	0.48	1.62	1.38	1.78	0.61	1.80	0.99	1.74	0.54	1.70	0.91
	(2.25)	(1.82)	**(2.73)**	**(3.14)**	**(2.38)**	**(2.48)**	**(3.26)**	**(3.62)**	**(2.34)**	**(2.43)**	**(3.28)**	**(3.49)**
P3	2.86	1.64	2.51	0.84	2.49	1.18	2.40	1.72	2.67	1.40	2.45	1.79
	(2.87)	**(3.29)**	**(2.74)**	(1.90)	**(3.12)**	**(3.94)**	**(3.65)**	**(4.01)**	**(3.04)**	**(3.92)**	**(3.32)**	**(3.15)**
H-L	1.68	1.46	1.47	1.11	1.27	0.88	1.25	1.15	1.47	1.16	1.36	1.12
	(3.70)	**(3.22)**	**(2.01)**	(1.41)	**(3.87)**	**(3.64)**	**(2.44)**	**(2.52)**	**(4.31)**	**(3.90)**	**(2.57)**	**(2.25)**

Note: Three portfolios from each young and mature firm were formed. The division of young and mature firms was performed using the median value of the age of a firm. Controlled portfolios were calculated using the average of both young and mature firms from each portfolio of MC. Values in parentheses denote *t*-statistics and values in bold represent significance at 5 percent or better.

4.5. Sub-Period Analysis

A sub-period analysis was also conducted for the results in Table 8 for the two sub-periods 2000–2007 and 2008–2019. The results were almost consistent with the overall sample and the monotonically increasing pattern was followed in both the sub-periods. The raw return differences in the high and low portfolios are statistically significant in both the sample periods and equal- and value-weighted returns. The four-factor alphas of the hedge portfolios are also statistically significant in three out of four cases. Overall, the results do not alter in the sub-periods.

Table 8. Sub-period results. This table shows the results from Table 2 for two sub-periods.

	July 2000-December 2007				January 2008-February 2019			
	EW Portfolios		VW Portfolios		EW Portfolios		VW Portfolios	
Portfolios	Excess return	4-F *a*	Excess Return	4-F *a*	Excess Return	4-F *a*	Excess Return	4-F *a*
Low	2.33	0.21	1.80	0.91	0.21	0.2	0.71	0.39
	(2.33)	(0.61)	(1.79)	**(2.02)**	(0.23)	**(1.09)**	(1.35)	(1.75)
2	2.62	0.02	3.2	1.41	0.52	0.48	0.91	0.62
	(2.56)	(0.04)	**(3.89)**	**(2.65)**	(0.59)	**(2.14)**	(1.52)	**(2.01)**
3	3.12	0.02	2.96	1.4	0.79	0.76	1.4	1.17
	(2.36)	(0.04)	**(2.77)**	**(2.34)**	(0.79)	**(3.02)**	**(2.06)**	**(3.43)**
4	3.69	0.72	3.64	2.24	1.44	1.42	0.93	0.77
	(2.75)	(1.28)	**(3.32)**	**(2.79)**	(1.49)	**(4.63)**	(1.48)	**(2.10)**
High	4.3	1.32	4.24	2.35	1.27	1.27	2.11	2.14
	(2.95)	**(2.15)**	**(3.42)**	**(2.97)**	(1.28)	**(3.66)**	**(2.41)**	**(4.19)**
H-L	1.97	1.1	2.44	1.44	1.06	1.07	1.39	1.74
	(2.97)	**(2.2)**	**(2.38)**	(1.57)	**(3.31)**	**(3.61)**	**(2.52)**	**(3.90)**

Notes: The whole duration of the study has been divided into two sub-periods, i.e., 2000–2007 and 2008–2019. Values in parentheses denote *t*-statistics and values in bold represent significance at 5percent or better.

In line with the existing research (Leung et al. 2020), we emphasised R&D intensity as the ratio of R&D expenditure to market value RDIMV) while measuring the industry-wise analysis, bivariate analysis, and sub-period analysis for multiple reasons. Previous research indicates that RDI(MV) is linked to higher abnormal returns compared to other measures like R&D expenses to book value RDI(BV) or total sales RDI(S) (Chan et al. 2001; Al-Horani et al. 2003). Furthermore, RDI (MC) can be likened to price multiples, making it easily applicable to an actual investment analysis. Furthermore, RDI(M) exhibits lower volatility over time and sectors compared to RDI(S), it is less enduring than RDI(P), and it is less susceptible to manipulation through creative accounting practices.

5. Conclusions

The paper probes the predictive power of R&D intensity for future stock returns and also examines whether the relationship between R&D intensity and stock returns is homogenous across six R&D-intensive industries in the Indian stock market. The study focuses on 1097 National Stock Exchange (NSE) listed companies belonging to six industries whose data on R&D expenditure was available in Prowess I.Q., a database maintained by the Centre for Monitoring Indian Economy (CMIE). Only 291 firms in the sample reported a non-zero R&D expenditure. Unlike most of the prevailing literature that focused on accounting performance measures like ROA and ROE, this paper examined the impact of R&D intensity on stock returns using the Fama and French (1993) portfolio formation method.

The results are summarised as follows. They suggest that R&D intensity positively affects future stock returns, in agreement with conclusions in previous studies of developed markets (for example, Connolly and Hirschey 2005; Li 2011; Ciftci et al. 2011). This result implies that investors are rewarded for investing in high R&D intensity companies. The results reveal a monotonic positive relationship between R&D intensity proxied by RDI(MC) and subsequent stock returns, i.e., the higher the R&D intensity, the higher will be the subsequent stock returns. The positive RDI–stock returns relationship is in conformity with the results of Chan et al. (2001), Eberhart et al. (2004), Songur and Heavilin (2017), and Sharma and Srikanth (2021).

The relationships between a battery of alternative measures of R&D intensity and other related measures were also tested. R&D activity-based portfolios, however, show that it is not R&D activity but R&D intensity that has a positive association with stock returns. RDI (M) exhibits lower volatility over time and is less susceptible to manipulation using new accounting approaches. As a result, the findings suggest that R&D intensity, rather than R&D activities themselves, is responsible for higher stock returns (Chan et al. 2001). Moreover, the findings show that R&D growth measures and R&D capital have insignificant relationships with stock returns. Further, industry-level portfolios reveal that the R&D effect is present primarily in the chemicals, drugs and pharmaceuticals, textiles, and transportation industries. The result of the double sorts of R&D intensity and firm age and market capitalization reveals that the R&D effect is robust to these controls. The key contribution of this paper lies in reporting the monotonic positive relationship between R&D intensity and stock returns in the Indian context. Consistent with a previous study conducted by Leung et al. (2020), we focused on R&D intensity as the ratio of R&D expenditure to market value RDI (MV) when performing the industry-wise analysis, bivariate analysis, and sub-period analysis for various reasons. Prior studies have shown that RDI (MV) is associated with greater abnormal returns in comparison to alternative measures such as R&D expenses to book value RDI (BV) or total sales RDI (S) (Chan et al. 2001; Al-Horani et al. 2003). Moreover, RDI (MC) can be compared to price multiples, which allows for its straightforward application in real investment analyses.

Further studies may explore the impact of patent filings on stock markets in both the short and long run. Additionally, patents serve as a defensive mechanism that companies can employ to prevent rivals from accessing the market for their products. Ongoing investments in research and development (R&D) generate perpetual knowledge capital, which serves as a foundation for endogenous economic growth. A nation can experience economic expansion by utilising its physical capital to generate knowledge capital, wherein the value of knowledge is regarded as having a positive correlation with the physical capital stock. Novel innovations that result from research and development endeavours are safeguarded by patent rights. Additional research yields novel products that serve as intermediaries in the development of additional innovations and inventions.

Given the expansive nature of R&D, greater emphasis should be placed on managerial-related facets of R&D activity. However, previous research provides managers with limited guidance. Managers involved in R&D must consider their course of action when confronted with economic uncertainty regarding R&D initiatives. In the first place, a study establishes that managers' investment decisions in R&D can impact the future development of an organisation. One way in which a research director may enhance sales is through the promotion of fruitful R&D initiatives. The difficulties associated with research and development (R&D) are highly pertinent not only to managers responsible for R&D but also to policymakers. From a policy standpoint, the study's findings provide insights into the relationship between R&D and firm value. Policy makers must grasp the significance of this relationship as it directly impacts the allocation of R&D resources and influences the strategic decisions made by companies. Furthermore, a crucial managerial implication for R&D policy makers is the comprehension of the time period in which returns on investment in R&D are realized. R&D programmes are characterised by their long-term nature and their enduring impact.

Emphasising the significance of research and development (R&D) in driving a country's economic growth is crucial. In the realm of global trade and the spread of information, a nation's ability to expand and compete is contingent upon its choices regarding investments in research and development (R&D). Hence, the results have significant ramifications for the formulation of economic policies, particularly in emerging nations like India. Specifically, the government should incentivise domestic enterprises to allocate resources towards research and development initiatives and foster partnerships for collaborative research and development endeavours among corporations.

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