JMK, VOL. 24, NO. 2, SEPTEMBER 2022, 118–128 DOI: 10.9744/jmk.24.2.118–128
ISSN 1411-1438 print / ISSN 2338-8234 online

EVALUATING R&D PREMIUM IN THE INDIAN HEALTH AND PHARMACEUTICALS INDUSTRIES

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Submitted: Aug 20, 2022; Reviewed: Sept 6, 2022; Accepted: Sept 21, 2022; Published: Sept 30, 2022

Abstract

The economic advantages of research and development (R&D) investment have shown conflicting results in empirical studies. This study aimed to examine a different approach, evaluating R&D premium and cross-sectional variability of equity returns, a particular case for the Indian healthcare industry. The primary motivation for this study arrived from the size of the healthcare industry, the world's third-largest and India's largest industry, and the investment made in R&D activities. Results demonstrated that India's annualized R&D premium was significantly greater than the current value, investment, profitability, and momentum premiums. It indicated that the new R&D risk factor in pricing models is a primary reference for Indian equity investors, particularly for companies with R&D spending. Results were robust in evaluating portfolio return using univariate and multivariate tests. Findings suggested that R&D augmented models outperformed conventional pricing models, denoting that the R&D factor undoubtedly revealed priced element and vital risk factor in designing pricing models for emerging countries like India. When adjusting to R&D investment and trading strategies, policymakers, and financial professionals should hereby evaluate their risk-return implications.

Keywords: R&D premium, asset pricing, cross-sectional models, portfolio management, healthcare industry.

Introduction

The economic advantages of research and development (R&D) investment have shown conflicting results in empirical studies. This study aimed to examine a different approach and look at how R&D investment affects the cross-sectional equity returns in the Indian Healthcare industry. Do companies that invest heavily in R&D activities generate greater equity returns for their investors in developing markets? Many studies show that traditional pricing risk-mimicking factors like size, market, value, momentum, investment, profitability, distress, patent citations, liquidity, and idiosyncratic volatility cannot fully describe the variability in equity returns in high R&D firms (Chen, Chen, Liang, & Wang, 2020; Sharma & Pyati, 2021). Several studies have shown substantial evidence that companies strive in R&D to obtain long-term strategic benefits, market value, and considerable equity returns (Chan, Lakonishok, & Sougiannis, 2001; Kim & Park, 2020; Yu, Liu, Fung, & Leung, 2020). Other studies argued that the risk-mimicking factor of R&D is a significant and necessary risk factor for estimating equity returns (Warusawitharana, 2015; Lin & Wang, 2016; Chen *et al.*, 2020; Yu *et al.*, 2020). According to scientific literature, R&D investments result in firms' long-term profitability, market value, and significant equity returns. In that case, our practical research question is whether there are any effective investment and trading strategies in high-R&D firms in the Indian healthcare industry.

The primary motivation of this study comes from the overall size of the healthcare industry (Health plus Pharma), which is the world's third-largest and India's largest industry, and the investment that it makes in R&D activities. With life expectancy rising from 64.20 years in 1990 to 72.60 years in 2019, the healthcare industry is becoming increasingly significant worldwide (Mittal & Sharma, 2021). According to India Brand Equity Foundation projections, the Indian healthcare industry is predicted to reach $372 bn by 2022, owing to rising income, lifestyle illnesses, improved health awareness, and more insurance coverage. According to a report published in healthcare finance, the healthcare industry has spent significant research and development investment in 2018 compared to previous years and was expected to invest the more by 2022. By 2020, India's healthcare industry was predicted to be among the top three globally and the largest among the Indian industries, providing investors in the field with a huge investment opportunity. The healthcare industry has grown into one of India's most significant industries in terms of employment and income. Hospitals, clinical trials, medical equipment, telehealth, outsourcing, health tourism, medical equipment, and medical insurance are all included in the healthcare industry. India's research and innovation ecosystems have been given much-needed attention in the Union Budget 2021–2022. Under "Innovation and R&D" was also introduced as one of the budget's six main components by providing more priorities for the healthcare industry.

Based on the present scenario of the healthcare industry and government involvement in R&D and innovation activities, the research and development investment study might be a notable firm risk characteristic for investors in predicting stock returns and company value. Lin and Wang (2016) suggested that R&D investments can boost competitiveness by improving work efficiency and designing new products. The economic gains aren't immediately apparent; therefore, R&D costs are considered high-risk investments. The problem of how R&D expenditure influences a company's worth isn't new, and there isn't much data to back it up. Different academics have different perspectives on a company's R&D spending decisions.

The signaling theory, as discussed by Ang and Cheng (2011), believes that firms gain by interacting with the market to eliminate asymmetric knowledge among insiders (management) and outsiders (market investors). Since high-quality firms with robust asymmetric knowledge are likely to be reasonable in the equity market, they could offer alternatives that their competitors cannot grasp. They may strive to transmit reports that equity investors identify as low-quality firms. Future stock-picking outflows are unknown, making R&D spending exceedingly uncertain. According to Kim and Park (2020), R&D investments signify more likely than different kinds of investments to result from knowledge asymmetry between management (insiders) and stock investors (outsiders). Cohen Diether, and Malloy (2013) argue that the investors require more long-term expected returns to compensate for the enormous risk of R&D investments, which likely lead to company mispricing.

There are limited studies focusing on developing economies, especially on Indian industries. This study is one of the first to examine the price of traded R&D return premium and cross-sectional examination of equity returns for the Indian healthcare industry as evidence for the emerging markets. This paper aimed to explore the R&D investments return premium for the Indian healthcare industry by modelling portfolio monthly excess returns using various pricing models; "Capital asset pricing model" (CAPM) (Black, Jensen, & Scholes, 1972), "3-factor asset pricing model" (3F) (Fama & French, 1993a), "4-factor asset pricing model" (4F) (Carhart, 1997) and "5-factor asset pricing model" (5F) (Fama & French, 2015). The study also shows the different style effects such as size, R&D, value, profitability momentum and investment by applying the different univariate and multivariate statistical methods. The fundamental goal of this study is to fill this research gap by examining price traded R&D risk-mimicking factor, which is calculated as active-minus-inactive R&D firms' portfolio average returns. This paper also examines the R&D risk factor enriched by the CAPM, 3F, 4F and 5F pricing models to evaluate the effect of pricing traded R&D return premium for the Indian healthcare industry.

R&D Investment and Firm Factor Characteristics

Many studies in finance literature suggest that high R&D intensive companies produce higher excess returns than low R&D intensive companies (Sharma, 2012; Lin & Wang, 2016; Chen *et al.*, 2020; Yu *et al.*, 2020; Su, Guo, Chai, & Kong, 2021) and offer reliable long-term profits to the market (Kim & Park, 2020). Pal and Nandy (2019) studied how diverse R&D investments of firms lead to innovation, create a relationship between innovation and company earnings, and show that R&D spending significantly affects firms' profitability. Nandy (2020) confirmed that the R&D efforts positively affect firm financial performance and profitability. Hsu and Cohen (2020) indicate that R&D expenses significantly influence firms' profitability, and factors returns vary by industry. Using R&D expenditures of firms and profitability, many studies have attempted to identify whether or what measure R&D intensive firms contribute to profitability (Lev & Sougiannis, 1996; Chan *et al.*, 2001; Lev, Sarath, & Sougiannis, 2005; Li, 2011; Warusawitharana, 2015). Those studies indicated a positive link, but they also suggested that R&D spending alone has little effect on profitability and stock returns after controlling firm-specific factors. Moncada-Paternò-Castello, Ciupagea, Smith, Tübke, and Tubbs (2010) described the industries' weighted R&D investment and show that healthcare and IT have a high R&D effect on stock returns. Several studies suggested that the research and development effect is more substantial for companies in industries with significant R&D (Chan *et al.*, 2001; Oh, 2017; Chen *et al.*, 2020). Wang (2011) presented that the companies that finance more in R&D are poised to receive positive abnormal returns than companies that do not. Donelson and Resutek (2012) showed that neither R&D spending nor the growth in R&D predicts expected returns; however, expected returns are entirely connected to present R&D investments. Hsu, Chen, Chen, and Wang (2013) showed that more R&D spending raises operational costs, reducing operating profits despite more significant net sales. It uses a variable that contains both choice and result characteristics. Vanderpal (2015) claimed that research and development positively impact firms' value.

Several studies have examined the association between R&D investments and various firm characteristics like profitability in the pharmaceutical industry (Pal & Nandy, 2019; Rao, 2020; Romasanta, van der Sijde, & van Muijlwijk-Koezen, 2020), financial performance (Nandy, 2020; Sharma, 2012), and equity returns (Mahlich & Yurtoglu, 2019). They claim that R&D expenses significantly impact on firm's profitability, financial performance, and stock returns. Many studies have also looked at stock returns and the role of R&D spending (Chan *et al.*, 2001; Gu, 2016; Lin & Wang, 2016; Chen *et al.*, 2020; Kim & Park, 2020; Yu *et al.*, 2020; Sharma & Pyati, 2021). They stated that R&D expenditure is a crucial risk factor in determining equity returns. Other studies and statistical analyses of R&D spending in similar cases in other emerging economies, such as Turkey (BaŞgoze & Sayin, 2013), China (Lu, 2020; Opoku-Mensah, Yin, & Addai, 2021; Su *et al.*, 2021), India (Majumdar, 2011; Sinha, Mishra, & Patel, 2019; Sharma & Srikanth 2021), and Pakistan (Ghaffar & Khan, 2014), have found an essential linked between R&D expenditure, firm value, and stock returns. Furthermore, the majority of previous studies on R&D return premium at the firm-and industry-level primarily focussed on high R&D economies such as the United States (Callimaci & Landry, 2004; Ehie & Olibe, 2010; Moncada-Paternò-Castello *et al.*, 2010; Dongmei, 2011; Yu *et al.*, 2020), South Korea (Kim & Park, 2020), Brazil (Silva, Klotzle, Pinto, & da Motta, 2018), China (Lu, 2020; Xu, Geng, Wei, & Jiang, 2020; Su *et al.*, 2021), Israel, Finland and Korea (Yury, Albert, & Ilia, 2017). This study fills this research gap by examining the R&D risk factor enriched by the CAPM, 3F, 4F and 5F pricing models to evaluate the effect of pricing traded R&D return premium for the Indian healthcare industry.

Research Methods

This study aimed to look at the R&D return premium in the Indian healthcare industry. Practising the most popular pricing models – CAPM (Black *et al.*, 1972), 3F (Fama & French, 1993a), 4F (Carhart, 1997) and 5F (Fama & French, 2015) – this study investigates the presence of a recurrent R&D return premium. It also tests the existence of different investment style effects such as size, R&D, value, profitability, momentum and investment.

Data

Dataset for factors like equity returns, stock price, PB ratio (price to book), book equity, sales, market equity, profitability (operating-profit), total assets, and R&D spending were collected using the Prowess-IQ financial database. It covered all BSE (Bombay Stock Exchange) listed R&D-intensive firms of health services and pharmaceutical industries between July 2009 and October 2021. It strictly followed the methods used by prior studies (Carhart, 1997; Fama & French, 1992, 1993a, 2015; Yu *et al.*, 2020) to avoid diversification issues and maintain an acceptable number of companies while computing variables developing alternative portfolios and testing pricing models. To prevent survivorship preference, stocks without R&D spending, negative PB, or missing data for the year were eliminated from the sample firms (Fama & French, 1996, 2020; Chambers, Jennings, & Thompson, 2002; Yu *et al.*, 2020). After considering the inclusion and exclusion criteria, the final sample comprised 1,416 health services and pharmaceutical firms over the sample assessment period. For the market risk factor design, the S&P BSE healthcare industry index-specific return was employed as a benchmark return for market proxy, and the rates of 91-days of T-bills (TB) were taken as a "risk-free (RF) rate of return".

R&D Ratio Measure

The R&D ratio was determined as the previous year's R&D expenses-to-market equity for computing the R&D risk factor and constructing the quintile and univariate sorted (2x3) portfolios (Chan *et al.*, 2001). The R&D intensive ratio was scaled with market equity (ME) since it delivered consistent average returns for the quintile portfolio than scaled with total assets (R & D-to- total assets) and sales (R & D-to-sales) (Yu *et al.*, 2020). P1 indicates the projected monthly average returns for a high R&D (active) stocks portfolio, whereas P5 represents the estimated monthly average returns for a portfolio of low R&D (inactive) intensive firms. The average returns in the quintile portfolios are coherent from high R&D to low R&D intensive stocks (see Figure 1).

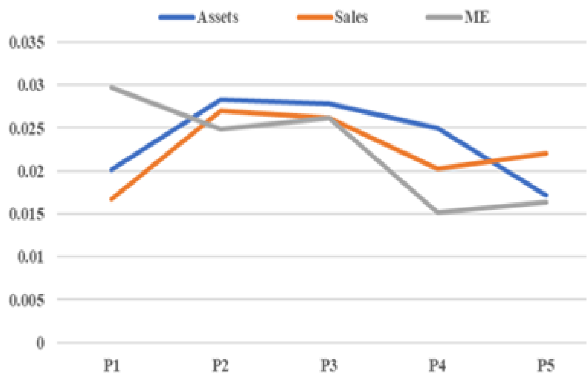

Figure 1. Quintile portfolio average returns

Variables and Portfolio Construction

To examine the pricing models, six specific risk-mimicking factors were adopted (size, R&D, value, profitability, momentum and investment). The tradable R&D factor (AMI) denotes the average returns of ACTIVE minus INACTIVE R&D intensive portfolios, the methodology described by a previous study (Chan *et al.*, 2001). Furthermore, following the scientific method described by earlier studies (Fama & French, 1993a, 2018; Chan *et al.*, 2001), six (2x3) univariate sorted size-to-value, size-to-R&D, size-to-profitability, size-to-momentum, and size-to-investment portfolios and factors were formed using the method followed by the French data library. All risk-mimicking factors were estimated utilizing equally weighted monthly returns. Furthermore, R&D quintile and 2x3 portfolios were developed to price traded R&D returns premium and examine different style effects to evaluate the univariate and multivariate pricing models. P1 to P5 represents the R&D quintile portfolios' monthly excess returns. These scales were created by comparing portfolio monthly returns of (high) active R&D (P1) (low) inactive R&D (P5) intensive firms.

Model Specification

Following prior investigations (Cremers, Nair, & John, 2009; Lin & Wang, 2016; Chen *et al.*, 2020; Sharma & Pyati, 2021), this study examines pricing models to evaluate the role of traded R&D return premium in the Indian healthcare industry. First, Equations 1–4 investigated the standard time-series pricing models single-factor-CAPM, 3F, 4F and 5F. Then the R&D risk factor was incorporated into the single-factor-CAPM, 3F, 4F, and 5F models and the resulting augmented models were tested in models 5–8.

$$R_{it-}R_{ft} = \alpha_i + \beta_{RmRf_i} *^{RmRf_t} + \varepsilon_{it} \quad (1)$$

$$R_{it-}R_{ft} = \alpha_i + \beta_{RmRf_i} *^{RmRf_t} + \beta_{SMB_i} *^{SMB_t} + \beta_{LMH_i} *^{LMH_t} + \varepsilon_{it} \quad (2)$$

$$R_{it-}R_{ft} = \alpha_i + \beta_{RmRf_i} *^{RmRf_t} + \beta_{SMB_i} *^{SMB_t} + \beta_{LMH_i} *^{LMH_t} + \beta_{WML_i} *^{WML_t} + \varepsilon_{it} \quad (3)$$

$$R_{it-}R_{ft} = \alpha_i + \beta_{RmRf_i} *^{RmRf_t} + \beta_{SMb_i} *^{SMB_t} + \beta_{LMH_i} *^{LMH_t} + \beta_{RMW_i} *^{RMW_t} + \beta_{CMA_i} *^{CMA_t} + \varepsilon_{it} \quad (4)$$

$$R_{it-}R_{ft} = \alpha_i + \beta_{RmRf_i} *^{RmRf_t} + \beta_{IMA_i} *^{IMA_t} + \varepsilon_{it} \quad (5)$$

$$R_{it-}R_{ft} = \alpha_i + \beta_{RmRf_i} *^{RmRf_t} + \beta_{SMB_i} *^{SMB_t} + \beta_{LMH_i} *^{LMH_t} + \beta_{IMA_i} *^{IMA_t} + \varepsilon_{it} \quad (6)$$

$$R_{it-}R_{ft} = \alpha_i + \beta_{RmRf_i} *^{RmRf_t} + \beta_{SMB_i} *^{SMB_t} + \beta_{LMH_i} *^{LMH_t} + \beta_{WML_i} *^{WML_t} + \beta_{IMA_i} *^{IMA_t} + \varepsilon_{it} \quad (7)$$

$$R_{it-}R_{ft} = \alpha_i + \beta_{RmRf_i} *^{RmRf_t} + \beta_{SMB_i} *^{SMB_t} + \beta_{LMH_i} *^{LMH_t} + \beta_{RMW_i} *^{RMW_t} + \beta_{CMA_i} *^{CMA_t} + \beta_{IMA_i} *^{IMA_t} + \varepsilon_{it} \quad (8)$$

According to Fama and French (1992, 1993a, 2006), the quintile portfolios' excess monthly returns were measured employing the multiple OLS regressions method described by Black *et al.* (1972). The efficacy of constructed pricing model intercepts was tested by practising the multivariate GRS analytical (Gibbons, Ross, & Shanken, 1989) model to conclude whether model intercepts (alphas) are equal to zero. In addition, the multivariate two-step Fama-MacBeth (1973) cross-section procedure was used to validate the results from the time-series regressions. The following equations were tested following the Equations specified by the Fama and Macbeth (1973).

$$r_{it} = \Upsilon^0 + \Upsilon^{1*}\beta_{RmRf,i} + \varepsilon_{it} \quad (9)$$

$$r_{it} = \Upsilon^0 + \Upsilon^{1*}\beta_{RmRf,i} + \Upsilon^{6*}\beta_{IMA,i} + \varepsilon_{it} \quad (10)$$

$$r_{it} = \Upsilon^0 + \Upsilon^{1*}\beta_{RmRf,i} + \Upsilon^{2*}\beta_{SMB,i} + \Upsilon^{3*}\beta_{LMH,i} + \varepsilon_{it} \quad (11)$$

$$r_{it} = \Upsilon^0 + \Upsilon^{1*}\beta_{RmRf,i} + \Upsilon^{2*}\beta_{SMB,i} + \Upsilon^{3*}\beta_{LMH,i} + \Upsilon^{6*}\beta_{IMA,i} + \varepsilon_{it} \quad (12)$$

$$r_{it} = \Upsilon^0 + \Upsilon^{1*}\beta_{RmRf,i} + \Upsilon^{2*}\beta_{SMB,i} + \Upsilon^{3*}\beta_{LMH,i} + \Upsilon^{6*}\beta_{WML,i} + \varepsilon_{it} \quad (13)$$

$$r_{it} = \Upsilon^0 + \Upsilon^{1*}\beta_{RmRf,i} + \Upsilon^{2*}\beta_{SMB,i} + \Upsilon^{3*}\beta_{LMH,i} + \Upsilon^{6*}\beta_{WML,i} + \Upsilon^{6*}\beta_{IMA,i} + \varepsilon_{it} \quad (14)$$

$$r_{it} = \Upsilon^0 + \Upsilon^1 {}^* \beta_{RmRf,i} + \Upsilon^2 {}^* \beta_{SMB,i} + \Upsilon^3 {}^* \beta_{LMH,i} + \Upsilon^4 {}^* \beta_{RMW,i} + \Upsilon^5 {}^* \beta_{CMA,i} + \varepsilon_{it} \quad (15)$$

$$r_{it} = \Upsilon^0 + \Upsilon^1 {}^* \beta_{RmRf,i} + \Upsilon^2 {}^* \beta_{SMB,i} + \Upsilon^3 {}^* \beta_{LMH,i} + \Upsilon^4 {}^* \beta_{RMW,i} + \Upsilon^5 {}^* \beta_{CMA,i} + \Upsilon^6 {}^* \beta_{IMA,i} + \varepsilon_{it} \quad (16)$$

The cross-sectional two-pass procedure examination of the CAPM, 3F, 4F and 5F models is expressed by the Equations in 9, 11, 13 and 15, respectively. Simultaneously, Equations 10, 12, 14, and 16 presented cross-sectional validation for R&D-factor augmented-CAPM, 3F, 4F, and 5F pricing models.

Result and Discussion

Evidence from the Descriptive Statistic

Table 1 presents the descriptive data statistics for the monthly average returns of the factor's premium. The average monthly R&D return premium for the Indian healthcare industry is 0.84%, which is higher than the other factor premiums such as value (-0.20%), profitability (0.30%), momentum (0.52%), and investment (0.11%). In addition, the monthly size premium is 1.10%, which is greater than other factor premiums. It was also reported that the existence and significance of the investing style effects, the R&D, size, and market premium were all positive and statistically significant. The value premium was negative, whereas profitability, momentum and investment were positive but not statistically significant. Connecting to current studies, the R&D monthly premium is 0.84% for the Indian healthcare industry, which is greater than the similar analyses by Yu *et al.* (2020) for the 'high- and low-tech' industry groups in the US market and by Kim and Park (2020) in the South Korean Equity Market. In addition, the Sharpe Ratio of the R&D premium was 17.86%, which was greater than the premiums for other parameters such as size (17.36%), market (16.56%), value (-5.61%), profitability (5.06%), momentum (10.50%), and investment (4.47%). This trend of the Sharpe ratio indicates that high R&D companies in the healthcare industry are less risky than low R&D companies.

Table 2 shows specific information for R&D quintile portfolio monthly excess returns. P1 signifies excess monthly returns for companies with high R&D, whereas P5 implies excess returns for firms with low R&D. The monthly abnormal return on portfolio P1 is 2.42%, while the monthly abnormal return on portfolio P5 is 1.21, implying that higher R&D intensive companies outperform lower R&D intensive companies in the Indian healthcare industry. Excess monthly returns to quintile portfolios rose steadily with companies' R&D investment. According to the findings, the annualized R&D return premium in the quintile portfolios (P1- P5) is roughly 15.60%, which is rather substantial.

Furthermore, the Sharpe ratio of P1 is 25.16%, higher than that of other quintile portfolios, which is a

Table 1
Descriptive Analysis for Factor Returns

	Rm-Rf (Market)	SMB (Size)	LMH (Value)	RMW (Profitability)	CMA (Investment)	AMI (R&D)	WML (Momentum)
Mean	0.009	0.011	-0.002	0.003	0.001	0.008	0.005
t-stat	2.01***	2.11***	-0.68	0.62	0.35	2.17***	1.28
Med.	0.007	0.002	-0.008	0.008	0.001	0.003	0.008
Min.	-0.104	-0.113	-0.088	-0.179	-0.131	-0.099	-0.154
Max.	0.259	0.198	0.126	0.146	0.125	0.121	0.157
SD	5.27%	5.53%	4.41%	5.28%	4.47%	4.28%	4.93%
Sharpe Ratio	16.56%	17.36%	-5.61%	5.06%	2.87%	17.86%	10.50%
Skewness	0.589	0.722	0.641	-0.726	0.068	0.512	0.423
Kurtosis	5.427	3.757	3.445	4.142	3.657	5.123	5.321
Jarque-Bera	44.917	16.403	11.304	21.061	10.404	34.023	18.143
Prob.	0.000	0.000	0.003	0.000	0.052	0.000	0.003
Obs.	148	148	148	148	148	148	148

Note (S): The market risk factor, Rm-Rf, is represented as the abnormal return for the market benchmark portfolio. SMB is the size factor differentiating small stock portfolio returns from large stock portfolio average returns. The value factor, LMH, is the variation in the portfolio returns of value-growth companies. RMW is a profitability risk factor that differentiates between robust-weak firms' average portfolio returns. CMA is an investment risk factor that indicates the difference in the average returns of portfolios of conservative-aggressive firms. WML defines the momentum factor, reflecting the portfolio's average return between past winners and losers' stocks. Likewise, AMI is the R & D risk factor, the premium in returns among active-R & D and inactive-R & D companies' portfolio average returns. *** defines 1%, and * represents 10% significant level.

Table 2
Descriptive Analysis for Univariate Quintile Portfolio Monthly Excess Returns

	P_1	P_2	P_3	P_4	P_5	P_1 - P_5
Excess return	0.024	0.020	0.022	0.010	0.012	0.013
t-statistic	3.261***	2.75***	3.02***	1.698	1.54	2.54**
Med.	0.020	0.014	0.014	0.014	0.008	0.010
Min.	-0.238	-0.186	-0.199	-0.183	-0.201	-0.115
Max.	0.487	0.385	0.301	0.314	0.318	0.181
SD	9.71%	8.62%	9.19%	7.01%	7.27%	5.76%
Sharpe Ratio	25.16%	22.65%	23.75%	13.96%	16.20%	21.93%
Skewness	0.932	0.679	0.446	0.335	0.623	0.436
Kurtosis	5.996	4.905	3.743	5.083	4.487	3.863
Jarque-Bera	76.785	33.820	18.297	29.568	23.518	11.574
Prob.	0.000	0.000	0.015	0.000	0.000	0.001
Obs.	148	148	148	148	148	148

Notes: The table displays statistical outcomes for quintile portfolios constructed by R&D-to-market equity ratio. P1 signifies the statistical findings for the portfolio of high R&D (active) firms that expected excess monthly returns, whereas P5 denotes the portfolio of low-R&D (inactive) firms that expected monthly returns. *** defines 1%, and ** represents 5% significant level.

positive indication for our conclusion that investors may reduce portfolio risk by owning these high R&D intensive stocks. These results are consistent with Sharma and Pyati (2021).

Evidence from Time-Series Regressions

Table 3 displays the findings of the standard and R&D risk factor augmented pricing models. The CAPM was adopted to determine whether the CAPM (Black *et al.*, 1972) explain cross-sectional variation on equity return towards quintile portfolios presented in Panel A. The results indicate that the market factor was influential at the 1% level, demonstrating that the market proxy is a good factor for CAPM. On the other hand, the intercepts from CAPM were substantial, excluding the low R&D portfolios (P4 and P5), implying that CAPM failed to represent the cross-sectional variation of equity returns. Panel B illustrates the R&D risk incorporated single-factor model to predict the variability of R&D quintile portfolios. The results show that this model performed since all intercepts were insignificant except for the natural portfolio (P3), and R^2 values were slightly improved.

Panels C and D show the results of an evaluation of the 3F model (Fama & French, 1993b) to evaluate the R&D return premium. The 3F and augmented 3F models were employed to determine whether they could explain the cross-sectional volatility in the R&D quintile portfolio monthly returns. The intercepts of the 3F model were statistical significance, implying that the model cannot adequately capture variability in stock returns for high R&D intensive portfolios.

In contrast, the R&D+3F model performs better because all intercepts became statistically insignificant, denoting that the R&D+3F can fully explain the cross-sectional variation in equity returns. Surprisingly, the R^2 values of the augmented model were much higher than those of the standard 3F model, implying that the augmented model (R&D+3F) outperforms the standard model. Panels E and F illustrate the four-factor (4F) (Carhart, 1997) and augmented 4F pricing models. The results demonstrate that augmented 4F models outperform 4F models since all intercepts became statistically insignificant, R^2 values were relatively higher, and factor risk coefficients such as market, value, size, and R&D were statistically significant.

Furthermore, the five-factor (5F) (Fama & French, 2015) model was examined to see whether it could capture the variability in R&D quintile portfolio excess returns. Panels G & H implications present the 5F and augmented 5F models. The findings reveal that the augmented 5F model performs well because the intercepts are insignificant, and the R^2 values are slightly higher than the conventional 5F model. Overall, it concluded that the results from time-series regression, the augmented pricing models outperform conventional models in capturing cross-sectional variability in equity returns, particularly for highly intensive R&D firms in the Indian healthcare industry. In the case of the investment style effects, size, value, and R&D characteristics are statistically substantial for the bulk of all portfolios, indicating that the healthcare industry has substantial size, value, and R&D effects. However, profitability, momentum, and investment effects were mixed.

Evidence from Multivariate GRS Test

In this part, it used the multivariate GRS test to evaluate the presented pricing models' fitness while developing the portfolios by R&D ratio and univariate (2x3) size/R&D, size/value, size/momentum, size/profitability, and size/investment firm characteristics for the Indian healthcare industry. The GRS test is used to evaluate asset pricing time-series models' fitness or analytical power.

Table 4 illustrates the GRS statistics for each existing and R&D risk factor augmented pricing model while sorting the stocks by size, R&D, value, momentum, profitability and investment. The existing models contradict the null hypothesis that the alphas (intercepts) from the model are equalized to zero because the *p-value* of each model is less than 5%, indicating that models cannot define the variability of equity returns for the healthcare industry. Nevertheless, the *p-values* of all augmented models, except for CAPM, are significant and more than 5%, denoting that it could not reject the null hypothesis and that the models performed well in defining the variability of stock returns. While portfolios are constructed based on firm size and R&D ratio, both existing and augmented models, except CAPM, have *p-values* greater than 5%, showing that models perform well; however, augmented models have generated higher *p-value* than existing pricing models. Another intriguing finding was that when the portfolio was formed by size and value (P/B), the p-value of the augmented models, except CAPM, was found to be more than 94% and significantly higher than existing pricing models, indicating that the high R&D firms have considerable size and value style effects on equity returns. In terms of fitness and explanatory power of the pricing model, it observed consistent findings in both augmented and existing models when sorting stocks by firm size/profitability, size/momentum and size/investment because models exhibited similar R^2 and GRS *p-values*.

Evidence from Two-Step Fama-Macbeth Cross-Sectional Regressions

Table 5 shows the two-step cross-sectional Fama and MacBeth's (1973) regression results based on Equations 9 to 16. The Fama-Macbeth approach is used to validate the evidence from the time-series examination. For quintile and univariate (2x3) sorted portfolios in the Indian healthcare industry, it investigates the

Table 3
Asset Pricing Models and Test for R&D Risk-factor Premium

	P_1	P_2	P_3	P_4	P_5	P_1	P_2	P_3	P_4	P_5
	Panel A: CAPM (Black *et al.*, 1972)					**Panel B**: R&D + CAPM				
α	0.014**	0.009*	0.012***	0.001	0.005	0.010	0.006	0.011**	0.001	0.005
$\beta_{Rm\text{-}Rf}$	1.14***	1.14***	1.11***	0.95***	0.09***	0.94***	1.02***	1.054***	0.97***	0.95***
β_{AMI}	-	-	-	-	-	0.78***	0.49***	0.24**	-0.050	-0.29***
R^2	0.38	0.49	0.51	0.52	0.41	0.49	0.54	0.53	0.52	0.44
	Panel C: 3F model (Fama & French, 1993a)					**Panel D**: R&D + 3F model				
α	0.008**	0.007**	0.008**	-0.003	0.000	0.003	0.002	0.006	-0.002	0.004
$\beta_{Rm\text{-}Rf}$	0.96***	1.03***	1.03***	0.88***	0.83***	0.86***	0.96***	1.01***	0.91***	0.90***
β_{SMB}	0.95***	0.55***	0.59***	0.53***	0.73***	1.00***	0.58***	0.61***	0.52***	0.70***
β_{LMH}	0.51***	0.32***	0.21**	0.17**	0.003	0.27***	0.165	0.156	0.24***	0.17**
β_{AMI}	-	-	-	-	-	0.60***	0.38***	0.22*	-0.18**	-0.42***
R^2	0.83	0.68	0.72	0.74	0.72	0.88	0.71	0.73	0.75	0.77
	Panel E: 4F model (Carhart, 1997)					**Panel F**: R&D + 4F model				
α	0.007**	0.004	0.008**	-0.003	0.000	0.003	0.001	0.006	-0.002	0.003
$\beta_{Rm\text{-}Rf}$	0.96***	1.02***	1.02***	0.87***	0.83***	0.86***	0.96***	1.00***	0.91***	0.89***
β_{SMB}	0.95***	0.56***	0.59***	0.53***	0.74***	1.00***	0.59***	0.61***	0.52***	0.70***
β_{LMH}	0.54***	0.45***	0.27***	0.23***	0.052	0.31***	0.31***	0.22**	0.30***	0.21**
β_{WML}	0.057	0.27***	0.120	0.113*	0.096	0.067	0.28***	0.123	0.110	0.089
β_{AMI}	-	-	-	-	-	0.60***	0.39***	0.132	-0.18**	-0.42***
R^2	0.83	0.70	0.73	0.74	0.72	0.88	0.73	0.73	0.75	0.77
	Panel G: 5F model (Fama & French, 2015)					**Panel H**: R&D + 5F model				
α	0.008**	0.005	0.008**	-0.004	0.001	0.003	0.002	0.006	-0.002	0.004
$\beta_{Rm\text{-}Rf}$	0.95***	1.03***	1.02***	0.88***	0.83***	0.86***	0.97***	0.99***	0.91***	0.89***
β_{SMB}	0.93***	0.56***	0.58***	0.55***	0.73***	0.99***	0.60***	0.59***	0.54***	0.68***
β_{LMH}	0.45***	0.38***	0.25**	0.24***	-0.004	0.23***	0.24**	0.21**	0.31***	0.16*
β_{RMW}	-0.122	0.036	-0.053	0.14*	-0.027	-0.059	0.076	-0.042	0.123	-0.073
β_{CMA}	0.019	0.166	0.26***	-0.020	0.027	-0.054	0.120	0.25***	0.001	0.080
β_{AMI}	-	-	-	-	-	0.60***	0.38***	0.110	-0.18**	-0.43***
R^2	0.83	0.69	0.74	0.75	0.72	0.88	0.72	0.74	0.76	0.77

Notes: All risk-mimicking factors are tested for multicollinearity using the tolerances and VIF (variance inflation factor). Multicollinearity was encountered to be non-exist. ***, ** and * express the significance level individually at 1%, 5% and 10%.

explanatory strength of the most commonly used pricing models – single-factor-CAPM, 3F, 4F, and 5F. The findings show that the CAPM executes well and is significant only for quintile and size/R&D sorted portfolios, although the R^2 values in both existing and augmented models were relatively low. In the case of the 3F model, the augmented model performed better since R^2 values were considerably higher (more than 84%) for each portfolio style. The size factor was influential in all models and portfolios; however, the value factor was significant only in portfolios constructed by R&D quintile and size/R&D ratio. The augmented 4F model produced better R^2 values, but only the quintile, size/R&D, and size/value sorted portfolios. The 5F model, both existing and augmented models, exhibited similar trends, but none of the value, investment, and profitability factor coefficients were statistically significant. Surprisingly, the R&D risk factor coefficient was substantial for all models when the portfolios were constructed by R&D and size/R&D characteristics. This section also stated that the profitability, momentum, and investment factor coefficients were insignificant while evaluating existing and augmented models, indicating that the

Table 5
Two-Step Cross-Section Procedure Using Fama-Macbeth Pricing Tests

Model	Portfolio	γ^0	γ^1	γ^2	γ^3	γ^4	γ^5	γ^6	R^2	*F-stats. [p-value]*
CAPM	R&D Quintile	-0.023*	0.04***						0.30	8.09 [0.01]
	Size/R&D	-0.02*	0.037***						0.20	9.08 [0.00]
	Size/value	0.005	0.013						0.23	0.69 [0.41]
	Size/Profit.	0.005	0.013						0.21	0.46 [0.49]
	Size/Inv.	-0.06	0.08*						0.29	3.21 [0.08]
	Size/Mom.	-0.008	0.025						0.29	0.41 [0.52]
R&D factor augmented CAPM	R&D Quintile	-0.015	0.032					0.01**	0.59	4.05 [0.01]
	Size/R&D	-0.023	0.04**					0.009**	0.40	4.58 [0.01]
	Size/value	0.009	0.008					0.006	0.39	0.39 [0.67]
	Size/Profit.	-0.003	0.023					-0.007	0.41	0.82 [0.44]
	Size/Inv.	-0.04	0.049					0.045	0.47	1.61 [0.20]
	Size/Mom.	-0.037	0.058					-0.008	0.47	0.8 [0.45]
3F	R&D Quintile	0.07***	0.08***	0.03***	-0.017				0.77	6.08 [0.00]
	Size/R&D	-0.019	0.03**	0.01**	0.005				0.67	3.33 [0.02]
	Size/value	-0.013	0.028	0.01**	0.00				0.69	3.44 [0.02]
	Size/Profit.	0.01	0.004	0.01**	-0.009				0.69	2.6 [0.05]
	Size/Inv.	0.01	0.004	0.01**	-0.009				0.70	2.7 [0.04]
	Size/Mom.	0.10*	-0.089	0.011**	-0.014				0.64	2.9 [0.03]
R&D factor augmented 3F	R&D Quintile	-0.089	0.09**	0.04**	-0.006			0.04**	1.00	4.56 [0.00]
	Size/R&D	0.00	0.017	0.01**	-0.024			0.07**	0.81	3.56 [0.00]
	Size/value	0.002	0.01	0.01**	-0.002			0.018	0.86	2.74 [0.03]
	Size/Profit.	0.014	0.001	0.01**	-0.006			-0.02	0.89	2.34 [0.005]
	Size/Inv.	0.013	0.001	0.01**	-0.006			-0.02	0.89	2.56 [0.05]
	Size/Mom.	0.093	-0.081	0.01**	-0.016			-0.031	0.84	2.36 [0.04]
4F	R&D Quintile	0.07***	0.08**	0.03**	-0.016	0.005			1.00	4.56 [0.00]
	Size/R&D	-0.004	0.015	0.01**	-0.003	0.016			0.88	2.78 [0.03]
	Size/value	-0.004	0.016	0.01**	-0.003	0.016			0.86	3.78 [0.02]
	Size/Profit.	0.017	-0.001	0.01**	-0.02*	-0.01			0.88	2.3 [0.06]
	Size/Inv.	-0.021	0.033	0.009**	0.007	0.002			0.89	1.2 [0.32]
	Size/Mom.	0.077	-0.072	0.01**	0.004	0.005			0.84	2.18 [0.07]
R&D factor augmented 4F	R&D Quintile	0.036**	0.07**	0.023**	0.004	0.006		0.016***	0.94	4.56 [0.00]
	Size/R&D	-0.04	0.099	0.01**	-0.097	0.107		0.008**	0.89	3.1 [0.01]
	Size/value	0.001	0.01	0.01**	-0.002	0.005		0.014	0.79	2.23 [0.05]
	Size/Profit.	0.007	0.006	0.01**	0.006	0.012		-0.04	0.76	1.88 [0.10]
	Size/Inv.	-0.061	0.083	0.01**	0.009	0.026		-0.01	0.68	1.58 [0.16]
	Size/Mom.	0.086	-0.077	0.01**	-0.008	0.005		-0.025	0.78	1.96 [0.08]
5F	R&D Quintile	-0.038	0.036	0.032**	-0.003	0.000	0.07		0.89	4.56 [0.00]
	Size/R&D	0.056	-0.06	0.01**	0.018	-0.02	0.082		0.90	3.14 (0.01]
	Size/value	-0.003	0.016	0.01**	-0.002	0.014	0.016		0.87	2.23 [0.05]
	Size/Profit.	0.002	0.012	0.01**	0.001	0.003	-0.02		0.78	1.88 [0.10]
	Size/Inv.	-0.036	0.06	0.01**	-0.015	0.051	0.001		0.89	1.58 [0.16]
	Size/Mom.	0.163	-0.152	0.01**	-0.03	0.003	-0.01		0.88	1.96 [0.09]
R&D factor augmented 5F	R&D Quintile	-0.003	0.006	0.026***	-0.001	0.002	0.039	0.06**	0.97	4.56 [0.00]
	Size/R&D	-0.001	0.043	0.01**	0.03	0.026	0.069	0.008**	0.94	3.14 [0.00]
	Size/value	-0.003	0.015	0.01**	-0.002	0.015	0.017	0.002	0.95	2.23 [0.04]
	Size/Profit.	0.002	0.012	0.02**	0.00	0.003	-0.02	-0.02	0.92	1.88 [0.08]
	Size/Inv.	-0.036	0.056	0.01**	-0.016	0.051	0.001	-0.007	0.89	1.58 [0.16]
	Size/Mom.	0.011	0.016	0.01**	0.006	0.013	0.01	-0.022	0.91	1.96 [0.07]

Notes: The table represented the results from the two-step Fama-Macbeth procedure while testing existing and augmented pricing models such as CAPM, 3F, 4F, and 5F. ***, **, and * express the significance level individually at 1%, 5% and 10%.

portfolios' modest effects were found on profitability, investment, and momentum style.

The cross-sectional results suggest that incorporating the R&D risk factor into the CAPM, 3F, 4F, and 5F models aided in model improvement since the R&D risk factor coefficient is substantial for all portfolios of highly intensive R&D companies. The R&D risk factor added CAPM, 3F, 4F, and 5F models outperformed the conventional CAPM, 3F, 4F, and 5F models; however, all risk factor coefficients were not statistically significant. When it conducted the cross-sectional regressions, the firm size-and R&D-factors were consistently effective, especially for highly intensive R&D companies. It also reports that this section's results are consistent with the evidence from the time-series analysis.

Conclusion

The primary purpose of this paper is to analyze the new R&D factor in traditional pricing models, and the price traded R&D return premium for the healthcare industry. The CAPM, 3F, 4F and 5F pricing models were used in this study to examine the R&D return premium. The findings reveal a positive and significant R&D effect and premium returns exist in the healthcare industry. During the sample period, the annualized return premium is considerably significant than the current value, momentum, investment, and profitability premiums. For comparison, the R&D monthly premium return is 0.84% for the healthcare industry in India, which is greater than comparable investigations by Yu *et al.* (2020) for the 'high- and low-tech' industry groups in the US and by Kim and Park (2020) in the South Korean Equity Market. In addition, the Sharpe ratio of a portfolio of high R&D firms (P1) is 25.16%, which is greater than the Sharpe ratio of other quintile portfolios. This supports our conclusion that owning these high R&D intensive firms may help investors decrease portfolio risk.

The evidence from OLS regressions indicated that the augmented pricing models outperform conventional models in capturing cross-sectional variability in equity returns, particularly for highly intensive R&D stocks in the Indian healthcare industry. In the case of the investment style effects, size, value, and R&D factors are statistically substantial for the bulk of all portfolios, indicating that the healthcare industry has substantial size, value, and R&D effects. However, profitability, momentum, and investment effects were mixed. When time-series model intercepts were examined using a multivariate GRS test, the existing and augmented models, except CAPM, have *p-values* greater than 5%, denoting those models perform well. However, augmented models have generated a higher *p-value* than existing pricing models. Another intriguing finding was that when the portfolio was formed by size and value (P/B), the *p-value* of the augmented models, except CAPM, was found to be more than 94% and significantly higher than existing pricing models, indicating that the high R&D firms have considerable size and value style effects on equity returns. In terms of fitness and explanatory power of the pricing model, it observed consistent findings in both existing and augmented models when sorting stocks by firm size/profitability, size/momentum and size/investment because models exhibited similar R^2 and GRS *p-values*.

The outcomes of the paper show that the R&D extended single-factor-CAPM, 3F, 4F and 5F models perform well in explaining the variability of equity returns since they provided significant results when evaluating both cross-sectional and time-series multiple regression models. Finally, it stated that investors consider highly intensive R&D companies; the R&D factor is a significant predictor, and policymakers and investors could use R&D investment as a risk-mimicking factor when applying pricing models in the healthcare industry to improve investment and trading strategies. This study contributes to academia and investors setting strong pricing factor models for emerging nations like India. Investors who understand the favorable and vital R&D effect and premium returns for the Indian healthcare industry may make winning trading and investment decisions. The financial experts and portfolio managers may build portfolios using highly intensive R&D companies. From the outcomes of this study, it also suggested that the policymakers and investment professionals should examine both risk-return implications when adjusting R&D investments.

It investigates the R&D risk factor and test several pricing models for the Indian healthcare industry. It recommends that the R&D risk factor be estimated for companies, other industries/sectors, or nations that spend significantly on R&D activities. Furthermore, a time-inconsistent feature of the R&D may be predicted to identify fluctuations in R&D spending during periods of crisis and market uncertainty.

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