Relationship between R & D Cost and Profitability: An Empirical Case Study of Top Ten Pharmaceutical Companies of India

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Abstract

"The main focus of the Indian pharmaceutical companies is on the maximization of revenue and the profits, but the R&D Costof Indian pharmaceutical companies are alwayslower."Is this statement a myth or a fact? The main objective of the present study is to search answer to this appropriatequery. With the analysis of financial information of these companies, present article is an effort to find the correlation between the revenue, expenditures, R&D Cost and profit of this sector.

With special reference to top ten Indian pharmaceutical companies, present research also has an objective to put out the dissimilarity of the R&D Cost incurred during the last ten financial years. Through the use of Accounting Ratios and Multiple Regression Model, this study discloses that the R&D Cost of Indian pharma companies is continuously growing. However, the R&D Cost has a higher degree of correlation with the revenue and moderate correlation with the profit of these companies.

INTRODUCTION

Research and development work is essential for growth of all type of industries, especially for pharmaceutical companies. Continuous Research & Development work (R&D work) is vital for pharmaceutical companies, as it contributes to their earnings and profitability. The main aim of this work is to secure a long and healthy human life. Every year, a huge amount is spent by Multinational Pharmaceutical Companies on R&D, But Indian pharmaceutical Companies (here referred as IPCs) have been recognized for their smallamount of investment in R&D. Although Indian pharma Industry is well organized, developed and regulated sector and products of IPCs are worldwide accepted, but their R&D Cost is not up to the international standards.

KEY WORDS:

Indian Pharmaceutical Companies, R & D Cost, Multiple Regression Analysis, Total Revenue, Operating Profit, F-Test

R & D Cost

Any work, job or process which resolves scientific ambiguity with an objective to achieve progression in science is known as R&D work. Through R&D spending or cost, pharma companies not only try to search effective, suitable and fast treatment

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for chronic diseases but they also try to control their cost of production and maximize their earnings. All type of revenue and capital expenditures incurred over R & D work is known as R & D Cost.

Indian Pharmaceutical Companies (IPCs): An Overview

India is the largest suppliers of low-cost vaccines and generic drugs in the world. It is ranked as 12thlargest exporter of the pharmaceuticals in the international market with the export value of INR 14,62,600 million.
(Annual Report, 2020-21, Department of Pharmaceuticals, Ministry of Chemical and Fertilizers, Government of India)

A Brief Profile of Top Ten Indian Pharmaceutical Companies (IPCs)

Table I: Top Ten Indian Pharmaceutical Companies
A Breif Outline

S. No.	Name of the IPC	Registered Office	Est. Year	Total Revenue (F.Y.2022-23) (In Million INR)
1	Sun Pharma. Industries Ltd.	Mumbai	1983	438,857
2	Aurobindo Pharma Ltd.	Hyderabad	1986	248,554
3	Dr.Reddy's Laboratories Ltd.	Hyderabad	1984	245,879
4	Cipla Ltd.	Mumbai	1935	225,593
5	Zydus Lifesciences Ltd.	Ahmedabad	1952	172,374
6	Lupin Ltd.	Mumbai	1968	166,417
7	Glenmark Pharmaceuticals Ltd.	Mumbai	1977	129,901
8	Alkem Laboratories Ltd.	Mumbai	1973	115,993
9	Torrent Pharmaceuticals Ltd.	Ahmedabad	1959	96,202
10	Divi's Laboratories Ltd.	Hyderabad	1990	77,677

Source: Annual Reports of Companies (F.Y. 2022-23).

LITERATURE REVIEW

The study conducted on evaluation of the R&D expenditure of the IPCs authenticated the impact of economic liberalization on the R&D behavior of IPCs. It was found that there was a significant change in the R&D of IPCs during post NEP era (Prakash, 2003). A study of the data of pharmaceutical exports and the R&D spending's of Indian companies' showed high correlation between export intensity and R&D spending. The study also indicated that higher R&D investment leads to the higher amount of the export earnings (Sampath, 2005).

The analysis of the nature and objectives of R&D work of some large IPCs shows that IPCs are investing in R&D not only for new drug discovery, but for the growth of infrastructure to include and apply the external knowledge (Chaturvedi & Chataway, 2006). The R&D cost of large, medium and small pharmaceutical companies of India has the growth in R&D cost, for the large IPCs growth is greater than the growth for the general IPCs (Reddy, 2006).

A study on the effect of TRIPS on R&D activity of Indian pharmacy sector, underlined that during the Post TRIP period, a significant growth is visible in R & D Cost in terms of Drug Master Filings DMF and ANDA filings (Kiran & Mishra, 2011). In order to promote the investment of private sector R&D a new policy was introduced in 1990.The study analyzed the impact of these reforms on pharmaceutical R&D in India with special reference to rising R&D strategies **(**Reji, 2011)

The analytical study of the most relevant determinants of patent counts, discussed the economics of intellectual property right protection. The study is showing that there is no general agreement on which is the best patent policy

exist to promote innovation **(**Tyagi &Nauriyal, 2013). The study of entire process and origin of R&D work over two decades (1994 to 2014), along with details of companies and therapeutic focus, represents a significant contribution to the understanding of the current positions of research and development of pharma sector in India (Edmond, 2017)

The examination of export, R&D intensity, and patent filing data of IPCs between 2000 and 2019 revealed that there has been no significant increase in export earnings and R&D intensity, although there is a positive correlation between the two (Nandy & Sussan, 2021).There is still a need for improvisation in R&D policies to make stronger infrastructure in the pharmaceutical sector. In order to solve the issues of funding and coordination, additional support from government is also required (Vieira et al., 2023)

OBJECTIVES OF THE STUDY

- To analyze the changes in the Total Revenue, Operating Profit Margin and R&D Cost of selected IPCs in last ten years.
- To determine and analyze the degree of correlation between the Total Revenue and R & D Cost of selected IPCs.
- To determine and analyze the degree of correlation between the Operating Profit and R & D Cost of selected IPCs.

HYPOTHESES

H1: There is no significant change (Increase or decrease) in R&D Cost of Indian Pharma Companies in last ten years from 2012-13 to 2022-23.

H2: There is no significant correlation between R&D Cost and Total Revenue of Indian Pharma Companies in F.Y. 2012-13 and 2022-23.

H3: There is no significant correlation between R&D Cost and Operating Profit of Indian Pharma Companies in F.Y. 2012-13 and 2022-23.

RESEARCH METHODOLOGY

Sample Size

For the analysis of the R&D cost of IPCs, purposive sampling method is adopted. This sampling method is used when a research study is focused on comparatively small samples. Purposive sampling is useful to access a specific division of the population that shares certain features. So, top ten IPCs are selected as purposive sample for the study.

Following are the main reasons for such sample IPCs:

i. All these IPCs are well established and large cap companies.

ii. In aggregate, the revenue of all these IPCs is more than INR 17,60,080 million which is about 40% of revenue of entire pharma industry.

iii. These ten IPCs are exporting their products to more than 100 countries across the globe.

iv. These IPCs are the major producer of all kind of medicines and market leader in many products and divisions.

v. The revenue model and the expenditures incurred by these companies can be taken as standard for entire pharma industry of India.

Research Period

Present research is divided in two parts. First part is from 1st April 2012 to 31st March 2013 (F.Y. 2012-.13) and second part is from 1st April 2022 to 31st March 2023 (FY2022-23)

Data Sources

Present study is mainly based on published data. Information is collected from annual reports (for the FY 2012-13 and 2022-23) and from the websites of the top ten Indian Pharmaceutical Companies. The latest financial performance data of these companies are available till the FY 2022-23, so for the comparison of last ten years data, FY 2012-13 is also considered for the study.

Analytical Method and Hypothesis Testing Tools

i. R&D Cost Ratio (On Total Revenue): $\frac{\text{R\&D Cost} * 100}{\text{Total Revenue}}$

ii. R&D Cost Ratio (On Operating Expenditure):

$$\frac{\text{R\&D Cost} * 100}{\text{Operating Expenditure}}$$

iii. Operating Profit Margin (OPM): $\frac{\text{OPerating Profit} * 100}{\text{Total Revenue}}$

iv. Compounded Annual Growth Rate (CAGR): (Px) = Po (1+r)

v. F-Test (Variance Ratio) : $\frac{\text{Larger Vartiance}}{\text{Smaller Variance}}$ OR [S2/ S1]

vi. Multiple Regression Analysis by Ordinary Least Square (OLS) Method:

$$y = a + bx$$

Here:

y = A dependent variable,

a = Alpha is the intercept of the least square,

b = Beta is the slope of the regression line/coefficient,

x = An independent variable,

For the computation of the values of 'a' and 'b', following two normal equations are used,

which can be solved simultaneously by OLS Method:

$$\sum y = na + b\sum x$$

$$\sum xy = a\sum x + b\sum x^2$$

R&D Cost Analysis of Top Ten Ipcs

Table II: Total Revenue, Operating Expenditure, Operating Profit And R & D Cost of Top Ten Indian Pharma Companies (For The Financial Year 2012-13 & 2022-23)

(In Million INR)

(FOR THE FINANCIAL YEAR 2012-13)					
S. No.	**Company**	**Total Revenue**	**Operating Expenditure**	**Operating Profit**	**R&D Cost**
1	**Sun Pharma**	24,522	19,190	5,332	2,725
2	**AurobindoPharma**	55,695	44,620	11,075	2,085
3	**Dr. Reddy'sLab.**	116,270	91,640	24,630	7,670
4	**Cipla Ltd.**	82,974	60,650	22,324	3,638
5	**ZydusLifesciences**	30,943	28,660	2,283	4,427
6	**Lupin Ltd.**	71,508	52,240	19,268	7,099
7	**GlenmarkPharma**	20,479	16,170	4,309	929
8	**Alkem Lab.**	22,910	18,600	4,310	743
9	**Torrent Pharma**	27,672	20,760	6,912	1,263
10	**Divi's Lab.**	21,444	13,290	8,154	240
GRAND TOTAL		474,417	365,820	108,597	30,819

(FOR THE FINANCIAL YEAR 2022-23)					
S. No.	**Company**	**Total Revenue**	**Operating Expenditure**	**Operating Profit**	**R&D Cost**
1	**Sun Pharma**	438,857	345,809	93,048	23,077
2	**AurobindoPharma**	248,554	223,039	25,515	14,528
3	**Dr. Reddy' s Lab.**	245,879	192,463	53,416	19,381
4	Cipla Ltd.	225,593	185,515	40,078	3,862
5	**Zydus Life sciences**	172,374	143,846	28,528	10,455
6	**Lupin Ltd.**	166,417	157,893	8,524	12,800
7	**GlenmarkPharma**	129,901	113,231	16,670	12,500
8	**Alkem Lab.**	115,993	103,002	12,990	5,690
9	**Torrent Pharma**	96,202	74,802	21,400	5,160
10	**Divi,s Lab.**	77,677	57,417	20,260	6,940
GRAND TOTAL		1,917,447	1,597,017	320,429	114,393

Source: Annual Reports of All Companies, for F.Y. 2012-13 & 2022-23.

ANALYSIS (Table II)

A substantial growth is visible in all four segments i.e. total revenue, operating expenditure, operating profit and R&D Cost during last ten years for all the IPCs. But the growth rate of all ten IPCs in these segments is showing a significant variation during this period. In 2012-13, Dr. Reddy's Lab was on the top in terms of all four segments, but in 2022-23, it is now substituted by Sun Pharma.

In the terms of highest R&D Cost, in 2012-13 it was Lupin Ltd and now it is Sun Pharma. In the terms of lowest R&D Cost, in 2012-13 it was Divi's Lab and now it is Cipla Ltd.The R&D Cost of all the companiesis less than their operating profits, but in 2012-13, R&D Cost of Zydus and in 2022-23 the R&D Cost of Lupin is more than their operating profits.

For the further analysis, Table-III is presented as follows:

Table III: Comparative Analysis of Revenue, Expenditure, Profit and R & D Cost Of Top Ten Indian Pharma Companies (For The Financial Year 2012-13 & 2022-23)

S. No.	Parameter for Comparison	F.Y. 2012-13	F.Y. 2022-23
1	Mean of Total Revenue (In INR Mn.)	47,441.7	1,91,744.7
2	Mean of Operating Exp. (In INR Mn.)	36,582	1,59,701.7
3	Mean of Operating Profit (In INR Mn.)	10,859.7	32,042.9
4	Mean of R&D Cost (In INR Mn.)	3,081.9	11,439.3
5	CAGR of Total Revenue	*14.99%*	
6	CAGR of Operating Exp.)	*15.88%*	
7	CAGR of Operating Profit	*11.43%*	
8	CAGR of R&D Cost	14.01%	

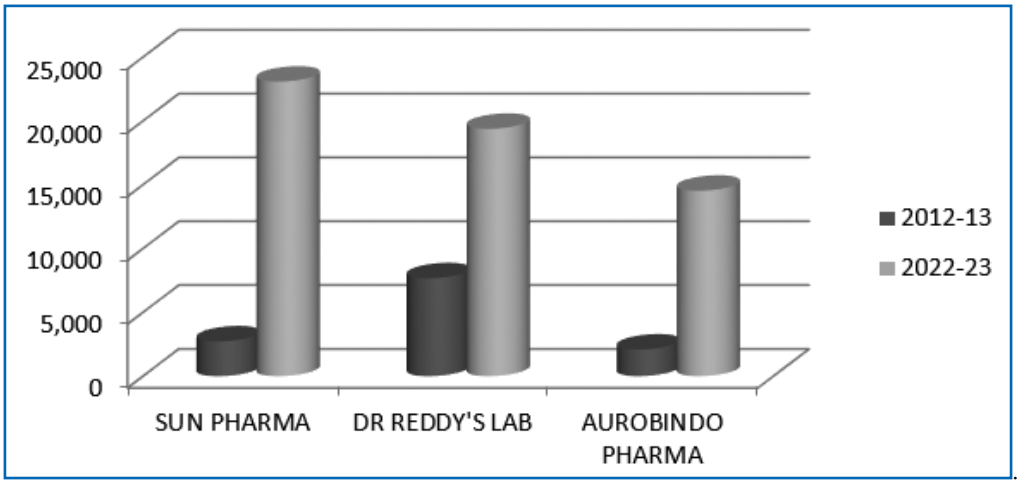
Source: Self Calculations on the basis of Annual Reports of IPCs for F.Y. 2012-13 & 2022-23.

ANALYSIS (Table III)

Highlight of the presented data is that the utmost CAGR in operating expenditure of IPCs as compared to all other parameters.The growth of total revenue and R&D Cost is just equal, which indicates that the R&D Cost of IPCs is growing with their revenue. CAGR of operating profit is least of all four segments. The mean R&D Cost is almost one third of their operating profits for both the periods, but the growth rate of R&D Cost is faster as compared with operating profit of these companies. It leads to an inference that IPCs are not concerned with the profits while spending the amount on their R&D.

Figure I: Top Threeindian Pharma Companies on the Basis Of R&D Cost (For The Financial Year 2012-13 & 2022-23)

(in Million INR)



Source: Self creation with the application of MS Excel, on the basis of Annual Reports of IPCs for F.Y. 2012-13 & 2022-23

Table IV: Operating Profit Margin (Opm) and R & D Cost Ratio of Top Ten Indian Pharma Companies (For The Financial Year 2012-13 & 2022-23)

(in Percentage)

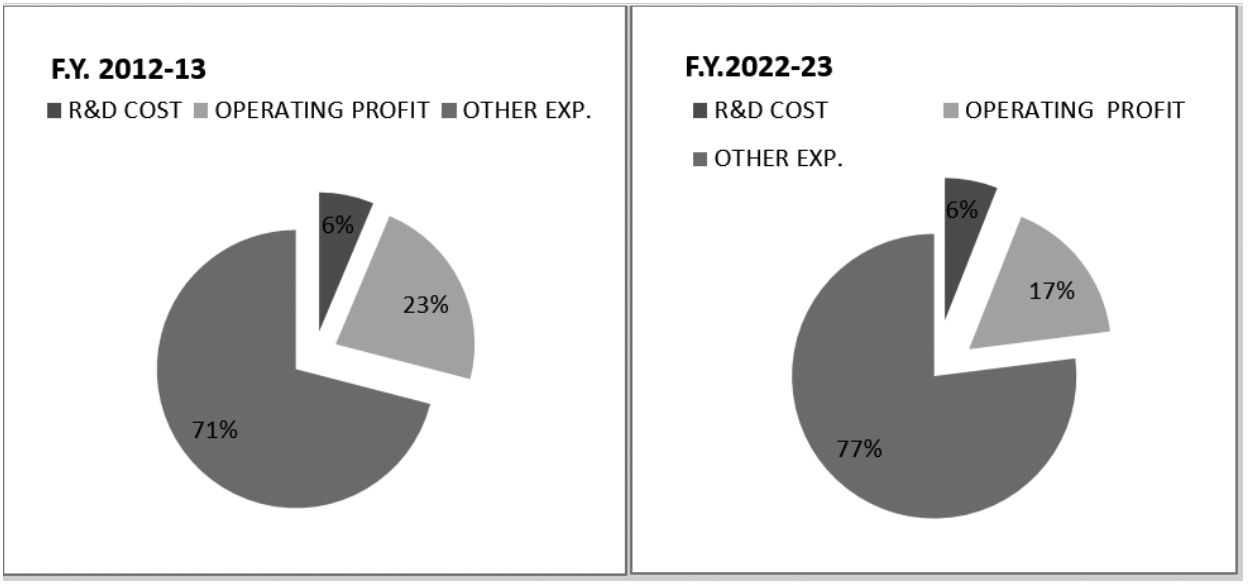
(FOR THE FINANCIAL YEAR 2012-13)				
S. No.	**Company**	**R & D COST RATIO**		**Operating Profit Margin**
		(On Total Revenue)	**(On Operating Expenditure)**	
1	Sun Pharma	11.1	14.2	21.74
2	Aurobindo Pharma	3.74	4.67	19.89
3	Dr. Reddy's Lab.	6.6	8.37	21.18
4	Cipla Ltd.	4.38	5.99	26.9
5	ZydusLifesciences	14.3	15.45	7.38
6	Lupin Ltd.	9.93	13.59	26.95
7	GlenmarkPharma	4.54	5.75	21.04
8	Alkem Lab.	3.24	3.99	18.81
9	Torrent Pharma	4.56	6.08	24.98
10	Divi's Lab.	1.12	1.81	38.02
MEAN		6.35%	7.99%	22.69%
(FOR THE FINANCIAL YEAR 2022-23)				
S. No.	Company	R & D COST RATIO		Operating Profit Margin
		(On Total Revenue)	(On Operating Expenditure)	
1	**Sun Pharma**	5.26	6.67	21.2
2	**Aurobindo Pharma**	5.85	6.51	10.27
3	**Dr. Reddy' s Lab.**	7.88	10.07	21.72
4	**Cipla Ltd.**	1.71	2.08	17.77
5	**Zydus Life sciences**	6.07	7.27	16.55
6	**Lupin Ltd.**	7.69	8.11	5.12
7	**Glenmark Pharma**	9.62	11.04	12.83
8	**Alkem Lab.**	4.91	5.52	11.2
9	**Torrent Pharma**	5.36	6.9	22.24
10	**Divi's Lab.**	8.93	12.09	26.08
MEAN		6.33%	7.63%	16.5%

Source: Self Calculations with the application of MS Excel, on the basis of Annual Reports of IPCs for F.Y. 2012-13 & 2022-23.

ANALYSIS (Table IV)

During last ten years, a noteworthy decay is visible in the mean operating profit margins. However, the mean R&D cost on total revenue and on operating expenditure is almost consistent at 7% and 8% respectively. In terms of R&D cost on total revenue for 2012-13, Zydus Life sciences was on the top, but now it is replaced by Glenmark Pharma. In terms of lowest R&D Cost Ratio, in 2012-13 it was Divi's Lab and now it is Cipla Ltd. A significance variation is visible in terms of R&D Cost Ratio of all the companies for both the years, but R&D Cost ratio of Dr. Reddy's Lab, Alkem Lab, Torrent Pharma and Lupin remains unchanged.

Figure II: Mean Of R&D Cost Ratio &Operating Profit Margin of Top Ten Ipcs (For The F.Y. 2012-13 And 2022-23)

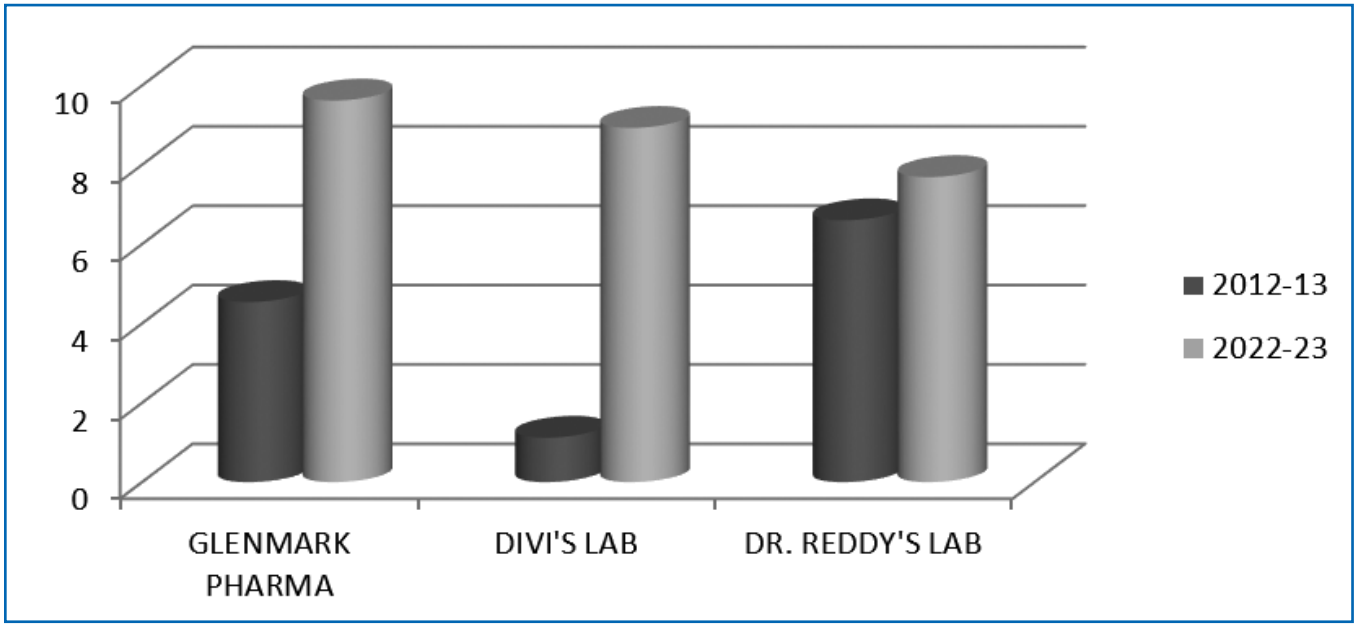


Source: Self creation using MS Excel based on Annual Reports of Companies, for F.Y. 2012-13 & 2022-23.

The highlight of the presented data is a significant decline in the Operating Profit Margin of almost all the companies. In spite of this decrease in OPM, their spending on the R&D is consistent in the terms of their total revenue. In 2012-13 the R&D Cost Ratio was 28% of their OPM, but in 2022-23 it is increased to 38%. It means the R&D Cost of IPCs is not concerned with their profit margins.

Figure III: Top Threeindian Pharma Companies on The Basis of R&D Cost Ratio (For The Financial Year 2012-13 & 2022-23)

(in Percentage)



Source: Self creation with the application of MS Excel, on the basis of Annual Reports of IPCs for F.Y. 2012-13 & 2022-23.

TEST OF HYPOTHESES

F-Test is a statistical test which is used for hypothesis testing to check whether the variances of two populations or two samples are equal or not. In present study we have to compare two samples (R&D Cost of IPCs for F.Y. 2012-13 and 2022-23). So for the comparison of variance, F-Test is applied in for the testing of first hypothesis.

The main objectives for calculation of multiple regression are:

i. To describe and understand the relationship between two or more variables.

ii. To forecast (predict) a new observation on the basis of available data.

As per second hypothesis we have to find out the degree of correlation/relationship between the R&D Cost and Revenue of IPCs. As per third hypothesis we have to find out the degree of correlation/relationship between the R&D Cost and operating profits of IPCs. Therefore, for the testing of this hypothesis, regression analysis is an ideal tool.

(H1): "There is no significant change (Increase or decrease) in the R&D Cost of Indian Pharma Companies in last ten years from 2012-13 to 2022-23."

Table V: F-Test (Variance Ratio)

Particulars	**R & D COST 2012-13**	**R & D COST 2022-23**
No. of Pairs (n)	n1 = 10	n2 = 10
Mean	x = 3,081.9	x = 11,439.3
Variance (S) :	S1 **=** 61,91,770	S2 = 3,62,13,539
F-Test (Variance Ratio) :	S2/ S1 = 5.85	
Degree of Freedom (d.f.)	(n1-1, n2 -1) = (9,9)	
Critical Value at 9,9 d.f. and 5% significance level)	3.18	
Result	Calculated Value > Critical Value 5.85 > 3.18 H1 : Rejected	
Alternative Hypothesis Accepted	"There is a significant change (Increase) in R&D Cost of Indian Pharma Companies in last ten years from 2012-13 to 2022-23."	

Source: Self Calculations with the application of MS Excelon the basis of Annual Reports of IPCs, for F.Y. 2012-13 & 2022-23.

(H2): "There is no significant correlation between R&D Cost and Total Revenue of Indian Pharma Companies in F.Y. 2012-13 and 2022-23."

Table VI: **Multiple Regression Analysis by Ordinary Least Square (OLS) Method**

(F.Y. 2012-13)				
Dependent Variable		R & D Cost		
Independent Variable		Total Revenue (TR)		
Sample		10 IPCs from F.Y. 2012-13		
Included observations:		10		
Multiple R		0.813838		
R Square		0.662332		
Adjusted R Square		0.620123		
Standard Error		1616.61713		
Variable	**Coefficients**	**Standard Error**	**t Stat**	**P-value**
a (Intercept)	19.207	926.88	0.020723	0.983974
b (Slope)	0.064556	0.016296	3.961304	0.004169
(F.Y. 2022-23)				
Dependent Variable		R & D Cost		
Independent Variable		Total Revenue (TR)		

Sample		10 IPCs from F.Y. 2012-13		
Included observations:		10		
Multiple R		0.775554		
R Square		0.601484		
Adjusted R Square		0.551670		
Standard Error		4247.30		
Variable	**Coefficients**	**Standard Error**	**t Stat**	**P-value**
a (Intercept)	2538.639	2892.23	0.877742	0.405671
b (Slope)	0.046419	0.0133587	3.474838	0.008382

Source: Self Calculationswith the application of MS Excel, on the basis of Annual Reports of IPCs, for F.Y. 2012-13 & 2022-23.

ANALYSIS (Table VI)

R-square

For both the years, the values of R-square or R-square adjusted are almost the same and express us how much independent variables are predicting (impacting) dependent variables. In 2012-13, the value of R square is 0.662, so 66.3% of independent variables are predicting R&D Cost. On other side in 2022-23 the value of R- square is 0.601, so 60.1% of independent variables are predicting R&D Cost. The comparison of both the periods shows that, total Revenue (TR) (independent variable) has a higher degree of correlation with R&D Cost.

P-Values

For both the years, P< 0.05, for 2012-13 it is 0.004169 and in case of 2022-23 it is 0.008382. Following the rule of thumb which states that if the p-value is lesser than 5%, the relationship is said to be significant if it is greater than 5%, it is insignificant. It means there is a significant correlation between the TR and R&D Cost.

Regression Equation

On substituting the results of the coefficients of a (intercept) and b (slope) in the regression equation (y = a + bx), it can be established that:

- **For 2012-13:**

  R&D Cost = 19.207852 + 0.064556 (TR)

  It means when the TR in this year is INR 1,00,000 then the amount of R&D Cost will be as under:

  R&D Cost =19.207 + (0.064556 *1,00,000)

  R&D Cost = 19.207 + 6,455.6

  R&D Cost = INR 6,474.81

- **For 2022-23:**

  R&D Cost = 2538.639 + 0.046419 (TR)

  It means when the TR in this year is INR 1,00,000 then the amount of R&D Cost will be as under:

  R&D Cost =2538.639 + (0.046419*1,00,000)

  R&D Cost = 2538.639+ 4,641.9

  R&D Cost = INR7,181

Hypothesis Test Result

As the summary interpretation, in 2012-13 R&D cost was INR 6,475 for every TR of INR 1,00,000, which is now increased to INR 7,181 in 2022-23. In this way a nominal increase of 0.7% is visible in the R&D Cost for the comparative period.

So, H2 is rejected and alternative hypothesis is accepted as:

"There is a significant correlation between R&D Cost and Total Revenue of Indian Pharma Companies in F.Y. 2012-13 and 2022-23."

(H3): "There is no significant correlation between R&D Cost and Operating Profit of Indian Pharma Companies in F.Y. 2012-13 and 2022-23."

Table VII: Multiple Regression Analysis By Ordinary Least Square (OLS) Method

(F.Y. 2012-13)				
Dependent Variable		R & D Cost		
Independent Variable		Operating Profit (OP)		
Sample		10 IPCs from F.Y. 2012-13		
Included observations:		10		
Multiple R		0.712427		
R Square		0.507552		
Adjusted R Square		0.445997		
Standard Error		1952.280		
Variable	**Coefficients**	**Standard Error**	**t Stat**	**P-value**
a (Intercept)	606.064	1060.450	0.5715154	0.983974
b (Slope)	0.227983	0.079395	2.871480	0.004169
(F.Y. 2022-23)				
Dependent Variable		R & D Cost		
Independent Variable		Total Revenue (TR)		
Sample		10 IPCs from F.Y. 2012-13		
Included observations:		10		
Multiple R		0.684173		
R Square		0.468093		
Adjusted R Square		0.401605		
Standard Error		4906.908		
Variable	**Coefficients**	**Standard Error**	**t Stat**	**P-value**
a (Intercept)	5914.719	2596.726	2.277759	0.052253
b (Slope)	0.172412	0.064979	2.653347	0.029104

Source: Self Calculationswith the application of MS Excell, on the basis of Annual Reports of IPCs, for F.Y. 2012-13 & 2022-23.

ANALYSIS (Table VII)

R-square

For both the years, the values of R-square or R-square adjusted are almost the same and express us how much independent variables are predicting (impacting) dependent variables. In 2012-13 , the value of R square is 0.507, so 50.7% of independent variables are predicting R&D Cost. On other side in 2022-23 the value of R- square is 0.468, so 46.8% of independent variables are predicting R&D Cost. The comparison of both the periods shows that, Operating Profit (OP) (independent variable) has a moderate degree of correlation with R&D Cost.

P-Values

For both the years, P< 0.05, for 2012-13 it is 0.020781 and in case of 2022-23 it is 0.029104. Following the rule of thumb which states that if the p-value is lesser than 5%, the relationship is said to be significant if it is greater than 5%, it is insignificant. It means there is a significant correlation between the Operating Profit (OP) and R&D Cost.

Regression Equation

On substituting the results of the coefficients of a (intercept) and b (slope) in the regression equation (y = a + bx), it can be established that:

- **For 2012-13:**

  R&D Cost = 606.064+ 0.227983 (OP)

  It means when the OP in this year is INR 1,00,000 then the amount of R&D Cost will be as under:

  R&D Cost =606.064+ (0.227983*1,00,000)

  R&D Cost = 606.064+ 22,798.3

  R&D Cost = INR23,404.36

- **For 2022-23:**

  R&D Cost = 5,914.719+ 0.172412 (OP)

  It means when the OP in this year is INR 1,00,000 then the amount of R&D Cost will be as under:

  R&D Cost =5,914.719+ (0.172412*1,00,000)

R&D Cost = 5,914.719+17,241.2

R&D Cost = INR 23,155.92

Hypothesis Test Result

As the summary interpretation, in 2012-13 R&D Cost was INR 23,404 for every OP of INR 1,00,000, which is marginally decreased to INR 23,155 in 2022-23. In this way a nominal decrease of 0.01% is visible in the R&D Cost for the comparative period.

So H3 is rejected and alternative hypothesis is accepted as:

"There is a significant correlation between R&D Cost and Operating Profit of Indian Pharma Companies in F.Y. 2012-13 and 2022-23."

FINDINGS AND CONCLUSION

Upto F.Y. 2000-01, R&D Cost of IPCs was 0.5% of their revenue. But during the last two decades, a significant growth is visible. Now R&D Cost of IPCs is around 6%-8% of their revenue. Still it is not up to global R&D spending standard which is around 15% of revenue. From the above analysis and the test of hypotheses the following conclusions can be drawn:

- The amount of R&D Cost of top ten IPCs is increased by almost four times.Test of first hypothesis proved that there is significance increase in the R&D Cost. But in terms of R&D Cost as percentage of revenue and expenditure, it is almost consistent.
- Significant growth is visible in all four segments i.e. total revenue, operating expenditure, operating profit and R&D Cost for all the IPCs.The R&D Cost of all the companies is less than their operating profits, but in 2012-13 R&D Cost of Zydus and in 2022-23 the R&D Cost of Lupin is more than their operating profits.
- Test of second hypothesis proved that there is high degree correlation between the R&D Cost and total revenue. The testing third hypothesis reveals that there is moderate correlation between R&D Cost and operating profits.
- On total revenue of INR 1,00,000, the R&D Cost of top ten IPCS is INR 7,181 and on operating profit of INR 1,00,000, the R&D Cost is INR 23,155.
- In spite of the decrease in OPM, spending on the R&D is consistent in the terms of their total revenue. In 2012-13 the R&D Cost Ratio was 28% of their OPM, but in 2022-23 it is increased to 38%. The growth rate of R&D Cost is much faster than the operating profit of these companies. It means the R&D Cost of IPCs is not disturbed with their profit margins.

In order to explore new markets in advanced countries like US, France, Germany, Britain, Australia, Japan etc. almost all theIPCs focus on the discovery of the new medicines through their extensive R&D work. Growth rate of R&D Cost ofIPCs is just equal to the growth rate of their revenue; it means with the increase of their revenue they are investing more amount son R&D. During last two decades, some IPCs are trying to improve their R & D facilities by increasing their R&D Cost continuously.

During the same period many IPCs have established their own large R&D centers as well and product development center with in the country and outside of the country. Their R&D work now recognized and certified by international standard authorities following strict regulations and standards. There is big opportunity for IPCs to capture fast growing global market and give tough competition to global pharmaceutical companies by improvement in their R&D work. IPCs are very strong in every field, but the investment in R&D, is a feeble point. All IPCs have realized this fact and are trying to invest the sufficient amount on the R&D to become world leader in R&D work.

LIMITATIONS

i. The analysis of R&D Cost iscompleted bythe use of R&D Cost Ratio (on the basis of total revenue and operating expenditure) Operating Profit Margin, CAGR and meanbased on the data of FY 2012-13 and 2022-23.

ii. Top ten IPCs are selected on the basis of their consolidated revenue for the F.Y. 2022-23

REFERENCES

- Prakash, P., J.(2003). Global Competitiveness ofIndian Pharmaceutical Industry: Trends and Strategies. Institute for Studies in Industrial Development. New Delhi.
- Sampath, P.,G. (2005).Indian Pharma with in global

Reach .Journal of Technology Analysis and Strategic Management.

- Chaturvedi, K. & Chatway, J. (2006).Strategic Integration ofKnowledgeinIndian Pharmaceutical Firms: Creating competencies for innovation. International Journal of Business Innovation and Research, 1.
- Reddy, S. (2006).Effects on the Pharmaceutical Industry and Access to Drugs.EconomicThesis Studied Online.
- Reji, K., J. (2011).The R&D Scenario in Indian Pharmaceutical Industry.Research and Information System for Developing Countries.
- Ravi,K.&Mishra, S. (2011). Research and Development, Exports and Patenting in the Indian Pharmaceutical Industry: a Post TRIPS Analysis. Eurasian Journal of Business and Economics, 4.
- Tyagi, S. & Nauriyal, D.K. (2013). Challenges and Prospects of Indian Pharmaceutical Sector: R&D, Innovation and Profitability.Global Journal of Management and Business Studies, 3.
- Edmond,D. (2017). The Drug Discovery and Development Industry in India—Two Decades of Proprietary Small-Molecule R&D.Chem Med Chem
- Nandy, Subhashis&Sussan, F. (2021). R&D Intensity and Export: The Case of Indian Pharmaceutical Industry. Review of Integrative Business and Economics Research, 10
- Marcela V., Tatiana A., Obaida K., Sanjida A., Srishti, Sebastian A.P., Adrian A.R., Kaitlin L., Yiqi L., Suerie M., NahitunN., AzizahS.& Syed M. A. (2023). Rising pharmaceutical innovation in the Global South: A Landscape Study. Journal of Pharmaceutical Policy and Practice, 16.
- Annual Reports of IPCs (F.Y.2012-13).
- Annual Report of IPCs (F.Y. 2022-23).
- Annual Reports of Pharma Exports Promotion Council of India.
- Annual Report, (2020-21). Department of Pharmaceuticals, Ministry of Chemical and Fertilizers, Government of India)