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Report

Impact of Government Incentivization on R&D Output of DSIR Recognized In-House R&D Units in Incentives Pharmaceutical Sector

-by

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Introduction

India is the 13th largest pharmaceutical (pharma) market in the world in terms of value and contributes 20 % volume share in the global pharma industry (Equity Master, 2016). The pharma sector of India has emerged as the largest producer of generic drugs exported worldwide and is strongly growing at 15% growth rate per annum and set to place itself amongst top pharma markets of the world (IBEF, 2017).

For the past two decades, India has carved a niche as a R&D hub because of immense pool of researchers and scientific manpower, lower cost of production as well as labour costs (IBEF, 2017). The notable increase in R&D intensity of Indian pharma industry for the past two decades can be attributed to a) enhanced investments in their R&D programmes, b) availing government initiatives to promote technological growth and innovation ecosystem in pharma sector c) patent act amendment-2005 and d) setting up R&D innovation centres by the global pharma units in India (IBEF, 2017).

Indian government has announced number of fiscal R&D incentives for private sector to stimulate private sector engagements in R&D especially in pharma industry, to generate innovative products and technologies in order to compete with MNCs and other global leaders in pharma industry (Joneja, 2015; Jawadekar, 2016; Pilla, 2016; http://pharmaceuticals.gov.in/). The fiscal R&D incentives can be availed by private sector upon recognition from an autonomous body 'Department of Science and Technology (DSIR; http://www.dsir.gov.in/)' under Ministry of Science and Technology, GoI, New Delhi. The major government mediated R&D incentives offered to private sector as of 2016-17 (http://www.dsir.gov.in/#files/12plan/bird-crf/fisr_annex.html) are listed below:

a) 150% weighted tax deduction on R&D expenditure incurred by DSIR recognized in-house R&D units under Section 35 (2AB) of Income Tax Act 1961

b) 100% write off on revenue expenditure on R&D under Section 35 (1) (i) of Income Tax Act 1961
c) 100% write off on capital expenditure on R&D under Section 35 (1) (iv) of Income Tax Act 1961
d) 200% weighted tax deduction for sponsored R&D programmes in approved National research laboratories, universities and IITs under Section 35 (2AA) of Income Tax Act 1961
e) 100% income tax rebate on donations made for scientific research to non-commercial R&D organizations approved under Section 35 (2) (ii) of Income Tax Act 1961
f) 150% income tax rebate on payments made for scientific research to National research laboratories and universities/research institutes approved under Section 35 (2) (iii) of Income Tax Act 1961
g) 10 year tax holiday to commercial R&D companies under Section 80 1B of Income Tax Act 1961
h) 40% accelerated depreciation allowance on investments made on new plants and machinery based out of indigenous technology as per Rule 5 (2) of Income Tax Act 1961
i) Custom duty exemption on goods imported for R&D
j) Central excise duty waiver for period of 3 years on specific goods designed and developed by Indian companies
k) 10% tax rate on royalty earned from the patent filed/granted
l) Funding schemes under various S&T ministerial heads/department of GoI

The present study was undertaken to examine the impact of fiscal R&D incentives availed by DSIR recognized pharma units on their financial performance.

Methodology

Nearly 10,000 pharmaceutical manufacturing units exist in India as per the 'Directory of Pharmaceutical Pricing Authority', GoI (http://www.nppaindia.nic.in/Directory-NPPA.pdf). As per DSIR directory, retrieved from http://www.dsir.gov.in, a total of 328 pharma units were recognized (by DSIR) till 2016. Nearly one third units (110) got recognition on or before 2005 and 87 units taken into this study. The financial information in terms of annual turnover, total sales and total assets was generated from the Prowess database published by Centre for Monitoring Indian Economy (CMIE). The present study was planned under the following subheads:

1. **Categorization of the DSIR Recognized In-House Pharma Units**

The units were categorized on the basis of location, scale of the industrial unit (large, medium and small) and research domains.

2. **Government-Mediated R&D Incentives Availed by the DSIR Recognized In-House Pharma Units**

The Indian government has introduced various incentives for units engaged in R&D. Major incentives fall in two categories i.e. a) Tax incentives on R&D expenditure, and b) Funding support in the form of grants, loans, equity and subsidies. In the current study, units availing government mediated tax incentives and funding support were considered. Data was collected in terms of total amount of funding support in the form of grants and loans from different government agencies availed by the pharma firms along with the total amount of tax rebate gained by pharma units on their R&D expenditure for the time period 2010-15. The statistical analysis through correlation and regression analysis was carried out using SPSS software version 21. The analysis was carried out to find out the relationship between government mediated incentives availed and R&D investment portfolio of pharma units. The null hypothesis formulated for the study was as: The R&D incentives positively affect and increase R&D investments and R&D

output of pharma units. The null hypothesis was checked by correlation and regression analysis of the data collected.

3. R&D Investments Undertaken by the DSIR Recognized In-House Pharma Units

R&D expenditure incurred by DSIR recognized in-house R&D units from 2005 to 2016 was collected from DSIR annual reports, DSIR recognition/renewal files submitted by industry to DSIR and prowess database (https://prowessiq.cmie.com/). R&D expenditure incurred by each unit was observed and percentage increase in R&D expenditure by each unit was calculated. Simultaneously, R&D intensity of each unit was also calculated by measuring the R&D investment incurred by each unit in terms of total output in the form of sales. The statistical analysis, in terms of correlation and regression analysis, was carried out using SPSS software version 21. The period of empirical analysis was from 2005 to 2016, in order to measure the impact of R&D investments in the pharma industry on the technological performance and financial sustainability of the select set of the pharma industry. The statistical study carried out as mentioned in figure 1.

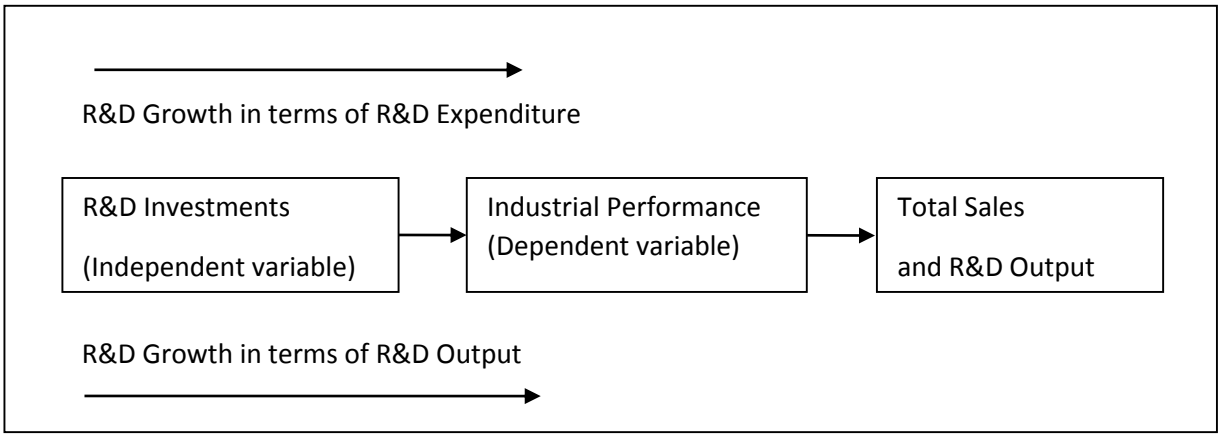


Figure 1: Study Design for Correlation and Regression Analysis

The null hypothesis formulated for the study was as follows:

Hypothesis 1: *R&D investments have a positive relationship with total sales of the industry set.*

Hypothesis 2: *R&D investments have a positive relationship with R&D output in terms of research publications, patents and technology commercialized/marketed of the industry set.*

In the present study, the overall growth of pharma industry in terms of growth in R&D investments and R&D output generated was also analysed by performing student t-test.

Results

1. Categorization of DSIR Recognized In-House Pharma Units

Based on region wise categorization of the DSIR recognized in house pharma units (87), maximum (34) are located in the state of Maharashtra, mainly in Mumbai and Pune. The second best preferred location is Telangana (14) followed by Tamil Nadu (9), Gujarat (8) Karnataka (5) Haryana (2) and Kerala (2). The states of West Bengal, Andhra Pradesh, Goa and Madhya Pradesh have only one DSIR recognized in-house pharma unit. Union Territories like Delhi and Chandigarh have 5 units and 1 unit, respectively.

On the basis of enterprise classification, 36 units fall under large scale, 39 units are medium scale and only 12 units belong to small-scale units. Out of 36 large scale industries, 30 units are public limited firms and only 6 units classify as private limited firms. Amongst medium scale industries (39) number of public and private units are 30 and 8, respectively. One of the medium scale units (Phytomyco Research Pvt. Ltd.) is 100 % export oriented unit. Amongst small-scale firms, 8 units are private limited units and 4 are public limited units (Figure 2).

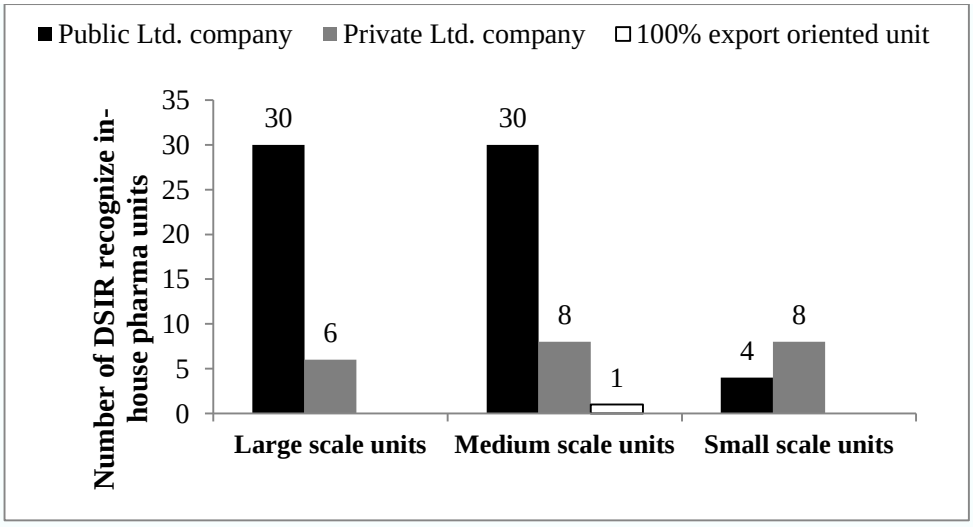


Figure 2: Categorization of Pharma Industry Set in Accordance to the Scale and Type of Industry

The industry set was also categorized in accordance to their research domain (Figure 3). Majority of the units (51) carry out research in the domain of pharmaceutical formulations and bulk drugs followed by research in the production of Active Pharmaceutical Ingredients (APIs) and fine chemicals (14 units) required for bulk production. Other units are engaged in the domain of ayurvedic medicines (4 units), vaccines and toxin productions (4 units) and veterinary medicines (3 units). Very few R&D units carry out research in the domains of drug discovery, innovative medicine, plasma fractionation, dosage level study, etc.

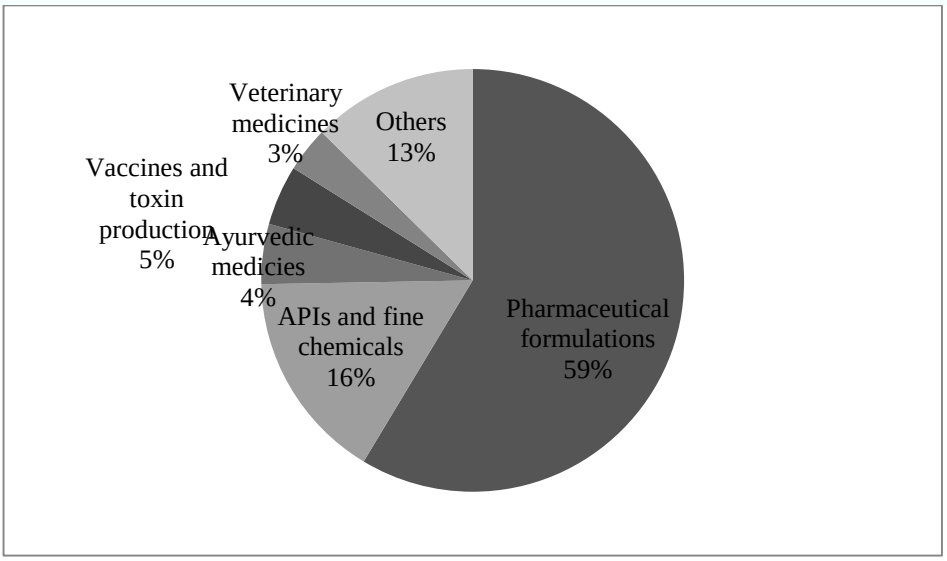
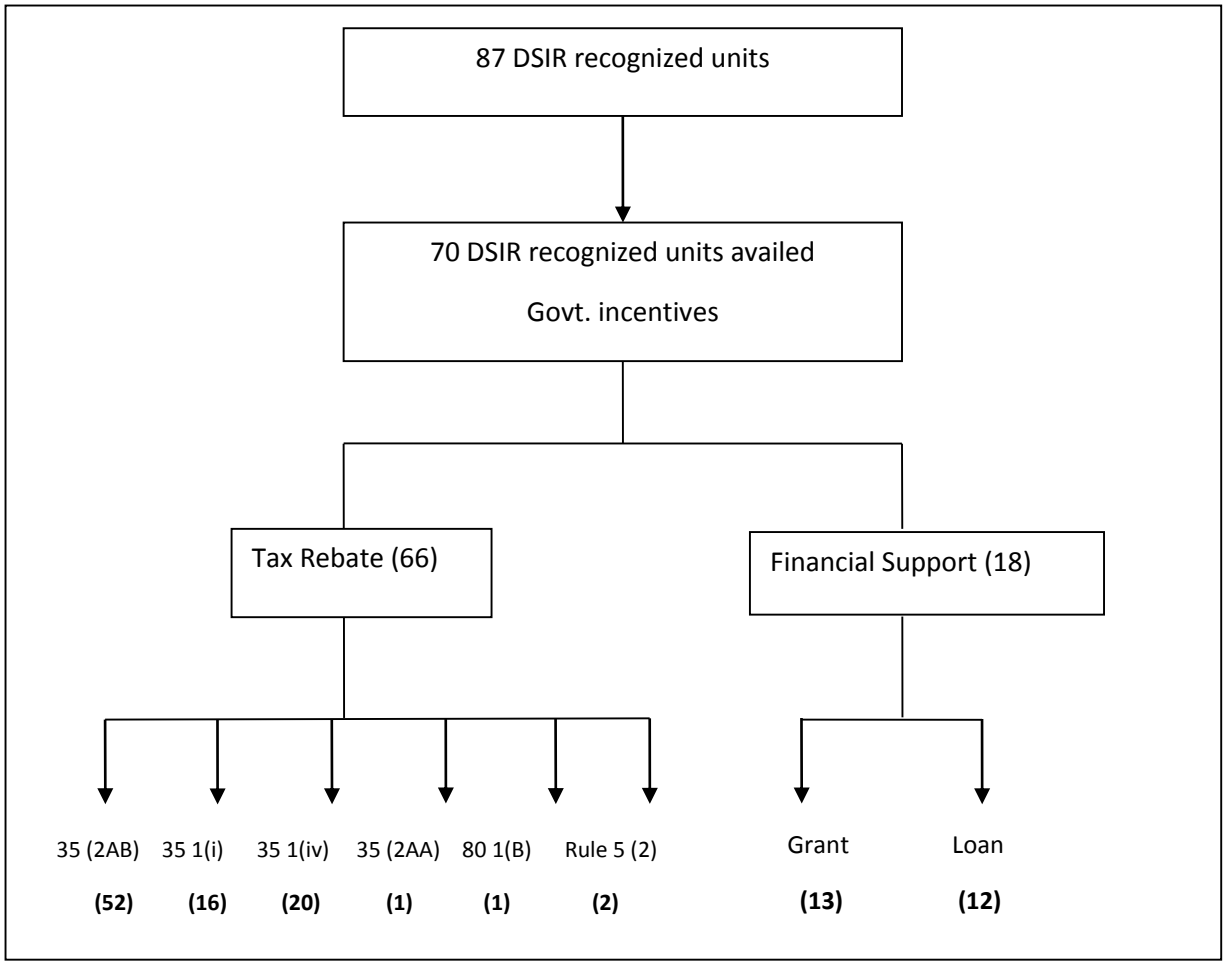


Figure 3: Categorization of Units Based on their Research Domains

2. Government Mediated R&D Incentives Availed by DSIR Recognized In-House R&D Pharma Units

The GoI provides two types of incentives, tax benefits and funding-support, for R&D specific activities undertaken by the private sector. Major tax benefits are a) weighted tax deduction of 150 % on R&D expenditure b) exemption from import and custom duty on importing R&D related items, and c) patent box regime. The funding support is leveraged through research funding programmes executed by S&T ministerial departments such as Department of Pharmaceuticals (DoP; http://pharmaceuticals.gov.in/), Department of Science and Technology (DST; http://www.dst.gov.in/) and Department of Biotechnology (DBT; http://www.dbtindia.nic.in/). Our study indicates that pharma sector prefers tax benefits over funding-support. More than 70%

of pharma units availed tax benefits and nearly 22% claimed funding support from government agencies such as DSIR, DST and BIRAC (Figure 4). Further it was observed, 17 units (large-5, medium-10 and small-2) did not avail any kind of government mediated R&D incentives for their R&D activities despite carrying out research activities and getting recognized by DSIR.



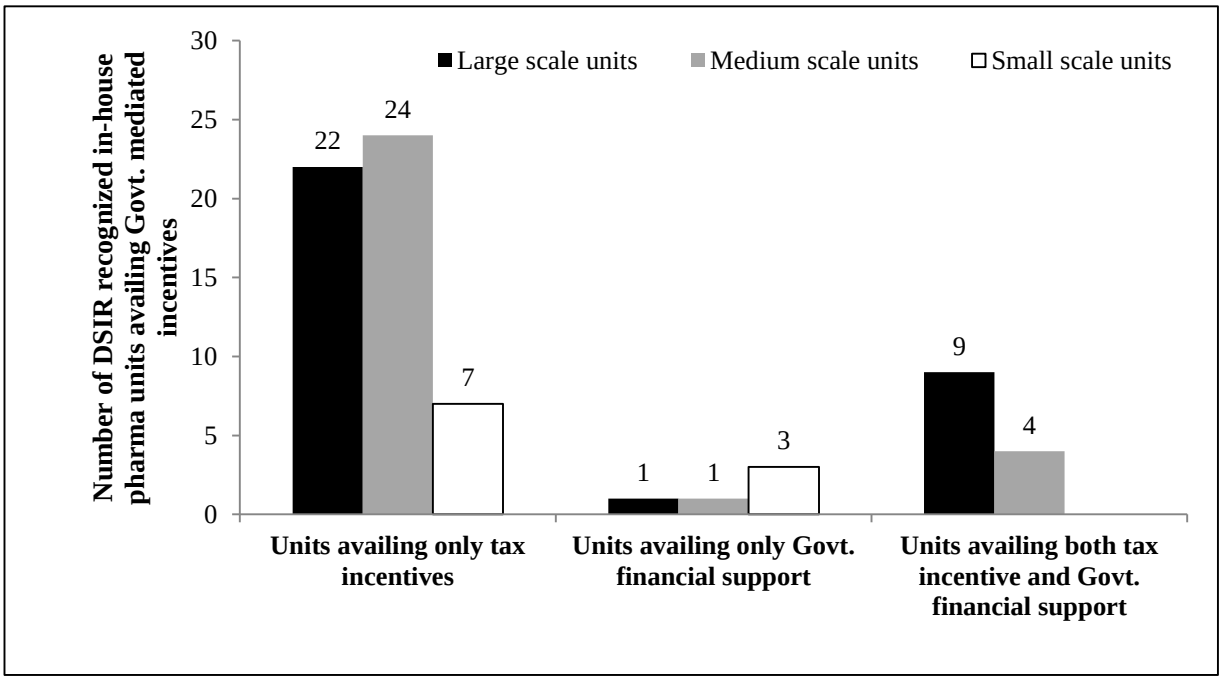


Figure 4: Categorization of DSIR Recognized Units Availing Govt. Incentives for R&D

Note: There are various units which have availed Govt. incentives in more than one category

a) Tax incentive on R&D expenditure

Out of a total set of 70 pharma units availing government incentives, 66 units (large-31, medium-28 and small-7) availed tax rebate on research expenditure. Fifty-three units (large-22, medium-24 and small-7) claimed only tax rebate and 13 units (large-9 and medium-4) claimed tax benefits as well as financial support (figure 4). As specified under Income Tax Act 1961, DSIR recognized units can avail tax benefits under various sections such as Section 35 (2AB), Section 35 1 (i), Section 35 1 (iv), Section 35 (2AA), Section 80 (1B) and Rule 5(2). Maximum number of units (52) availed tax rebate under Section 35 (2AB) followed by 20 units and 16 units utilizing tax-incentives under Section 35 1 (iv) and 35 1 (i) respectively (Figure 5). Only 1 large scale unit, 1 medium scale unit and 1 small scale unit availed tax benefit under Section 35 (2AA), Rule 5 (2) and Section 80 1(B), respectively. In addition, 23 units (large-13, medium-8 and small-2) availed tax rebates in two or more than two sections.

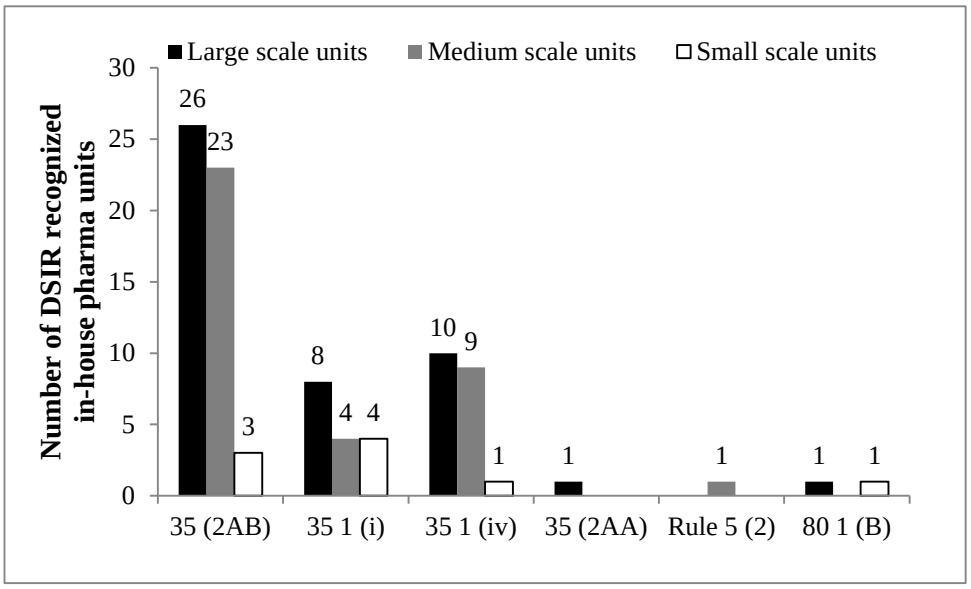


Figure 5: Number of Units Availing Tax Incentives under Various Sections of Income Tax Act 1961

b) Govt. mediated financial support for R&D

The Government mediated financial support for R&D purposes was availed by 18 units (large-10, medium-5 and small-3). Five units (large-1, medium-1 and small-3) claimed only financial support and 13 units (large-9 and medium-4) claimed financial support as well as tax benefits (figure 4). The financial support has two arms i.e. grant and loan. Out of total 18 units availing financial support, 6 (large-4 and small-2) received financial support in the form of only grant, 5 (large-2 and medium-3) received only loan and 7 units (large-4, medium-2 and small-1) received both grant and loan.

The statistical analysis of the impact of R&D incentives on R&D investment and R&D output of pharma firms showed that R&D incentives provided to these industries significantly ($p<0.000$) impact and increase the R&D expenditure of firms (Table 1). However, null hypothesis stood false, when R&D incentives availed by the industries was analysed in terms of R&D output generated by these firms. There was insignificant ($p>0.05$) relationship between both the variables.

Table 1: Statistical Analysis Output I of Correlation and Regression Analysis

Independent Variable	Dependent Variable	Period	β	R^2	Significant Value (p)
R&D Tax Rebate	R&D Investments	2010-15	0.897	0.805	0.000
R&D funding support	R&D Investments		0.656	0.430	0.000
R&D Tax Rebate	R&D output		0.007	0.000	0.944
R&D funding support	R&D output		0.554	0.126	0.195

3. R&D Investments of DSIR Recognized In-House Pharma Units

The detailed R&D portfolio of pharma units considered in our study is mentioned in annexure II. Majority (74) of units (large-32, medium-33 and small-9) have substantially increased their R&D investments in past 10 years as mentioned in table 2.

Table 2: DSIR Recognized In-House R&D Units Indicating Decrease/Increase in R&D Expenditure (2005-16)

S. No.	Attribute	Large Scale Units	Medium Scale Units	Small Scale Units
1.	Number of units showing >1000% increase in R&D Expenditure	3	8	0

2.	Number of units showing 500-1000% increase in R&D Expenditure	8	2	1
3.	Number of units showing 100-500% increase in R&D Expenditure	15	13	6
4.	Number of units showing 1-100% increase in R&D Expenditure	6	10	2
5.	Number of units showing decrease in R&D Expenditure	4	6	3

It is evident from the table 2, over 75% of units showed more than 100% increase in their R&D expenditure during time period 2005-16. Maximum percentage increase was observed by Ajanta Pharma Ltd. followed by Biological E Ltd. and USV Pvt. Ltd. Moreover, the study also listed top three R&D investors from each unit category (large, medium and small scale units) as listed in table 3.

Table 3: Top 3 R&D Investors under Large, Medium and Small Scale Category

S. No.	**Firm**	**R&D Expenditure (2016) Rs millions**
Large Scale Units		
1.	Macleods Pharmaceuticals Ltd.	1625.4

2.	Dr Reddy's Laboratories Ltd.	787.61
3.	Cadila Healthcare Ltd.	538.00
Medium Scale Units		
1.	Bharat Serums Ltd.	264.50
2.	USV Pvt. Ltd.	193.60
3.	Suven Life Sciences Ltd.	130.50
Small Scale Units		
1.	Avra Laboratories Pvt. Ltd.	28.00
2.	Khandelwal Laboratories Ltd.	19.80
3.	Lifecare Innovations Pvt. Ltd.	8.10

The statistical analysis of the R&D expenditure and related data collected for the period 2005-16 revealed that R&D expenditure incurred by DSIR recognized in-house pharma units showed positive and significant relation ($p<0.000$) with generated total sales of the units (Table 4).

Table 4: Statistical Analysis Output II of Correlation and Regression Analysis

Independent Variable	**Dependent Variable**	**Year**	**β**	**R^2**	**Significant Value (p)**
R&D Expenditure	Total Sales	2005	0.783	0.613	0.000
		2006	0.879	0.773	0.000
		2007	0.841	0.707	0.000

		2008	0.887	0.787	0.000
		2009	0.885	0.783	0.000
		2010	0.858	0.736	0.000
		2011	0.855	0.731	0.000
		2012	0.880	0.775	0.000
		2013	0.872	0.761	0.000
		2014	0.871	0.759	0.000
		2015	0.901	0.813	0.000
		2016	0.876	0.767	0.000
		Overall (2005-16)	0.875	0.765	0.000

- Correlation is significant
- Null hypothesis stands true
- There is positive relationship between R&D expenditure and the total sales of DSIR recognized pharmaceutical industry set.

A correlation and regression analysis for determining the relationship between R&D investments and R&D output (number of research publications, patents, products/process and technologies commercialized) generated was also examined. It was observed that there was insignificant relationship ($p>0.05$) between both the variables (Table 5).

Table 5: Statistical Analysis Output III of Correlation and Regression Analysis

Independent Variable	Dependent Variable	Year	β	R^2	Significant Value (p)
R&D Expenditure	R&D Output	2005	0.017	0.000	0.877
		2006	0.009	0.000	0.934
		2007	0.005	0.000	0.963
		2008	0.013	0.000	0.904
		2009	0.048	0.002	0.644
		2010	0.066	0.004	0.525
		2011	0.084	0.007	0.421
		2012	0.021	0.000	0.840
		2013	0.030	0.001	0.772
		2014	0.158	0.025	0.126
		2015	0.011	0.000	0.917
		2016	0.021	0.000	0.857
		Overall (2005-16)	0.031	0.001	0.310

- Correlation is insignificant
- Null hypothesis stands false
- There is no relationship between R&D expenditure and the R&D Output of DSIR recognized pharmaceutical industry set.

The analysis of the overall growth of pharmaceutical industry during the time period 2005-16 showed a significant increase ($p<0.000$) in the R&D investments as well as in the R&D output (Table 6).

Table 6: Growth in R&D Expenditure (t-test output)

Pair	N	Correlation	p (Significant Value)
R&D Expenditure 2005-16	75	0.768	0.000
R&D output 2005-16	103	0.999	0.000

Discussion

As per 'Directory of Pharmaceutical Manufacturing Units in India' issued by National Pharmaceutical Pricing Authority (NPPA), GoI, there are ~10,000 pharmaceutical companies in India. However, only a small percentage (0.035%) is availing R&D benefits offered by GoI. The possible factors for this could be lack of awareness about DSIR incentives, lengthy process to file an application, too much time taken by DSIR to grant accreditation and not much excitement to get accreditation as incentives which are much below expectations. It is high time, GoI has to relook on these issues and modify existing incentives and protocols on the lines of rules/regulations of countries such as USA, U.K., Japan, S. Korea and China where getting government accreditation is not mandatory and it's simple to apply and receive government R&D incentivization.

In India, there are 6 dominant pharma clusters located in the states of Maharashtra, Madhya Pradesh, Andhara Pradesh, Telangana, Punjab and Himachal Pradesh (IBEF, 2017). However, majority (55%) of the DSIR recognized units are present in Maharashtra and Telangana clusters which could be attributed to various factors including lucrative incentives offered by the

respective state governments for setting up industrial plants, ports accessibility, availability of skilled workers and better awareness about R&D incentives offered by the central government of India.

The study reveals that DSIR recognition is availed mainly by large scale and medium scale industrial units only. It is understandable as small scale industries fall short of financial resources to carry out meaningful R&D. Similar statement has been echoed by Bedi *et al*. (2013) and Pardhan (2013). The R&D ecosystem of SMEs can be boosted by provision of dedicated government incentives such as higher rates of tax rebate for small SMEs as practiced in S. Korea- tax credit of 50% for small SMEs in comparison to 40% for medium-sized units and 30% for large-sized units and Japan following- 17% tax credit rates for SMEs and 6-10% for large-sized units (Deloitte 2017; PwC 2017). Moreover, as in U.K., a special tax incentive has been introduced for SMEs facing loss situation (Deloitte 2017; PwC 2017). Implementation of such incentives will encourage SMEs to stride the path of innovative research (Deloitte 2017; PwC 2017).

The present study has clearly indicated that pharma units prefer tax incentives over financial support offered by the government to promote R&D of the pharma units. Similar observation has been endorsed by others in India and other developed economies (Agrawal *et al*., 2014; Pringle, 2015 and Guceri and Liu, 2017). Our study also embodied that majority of the R&D units availed tax rebate under Section 35 (2AB) of Income Tax Act 1961 (R&D expenditure incurred by company except land and building cost associated with the R&D), followed by Section 35 1 (iv) (tax deduction on revenue expenditure associated with R&D) and Section 35 1 (i) (tax deduction on capital expenditure associated with R&D). A very few opted for other form of tax rebate under Section 35 (2AA) (tax rebate for carrying out sponsored R&D programme with Indian research and academic institutes); Section 35 2(ii) (tax rebate on donation money for scientific research purpose); Rule 5 (2) (accelerated depreciation allowance on machinery and equipments related to R&D). This data is suggestive of poor linkages of industries with public

research institutes. Linking of industries, especially SMEs, with universities and national research laboratories will certainly enhance their R&D capabilities and outputs. Developing Industry-Academia web portal, addressing the availability of scientific/technical expertise, presence of infrastructure facilities (instruments, library, Centres of excellence, etc.) in the region will certainly bring industry and academia closer to each other. Recently, a regional Industry-Academia web portal (http://iacrikc.dstcpr.in/) has been developed by DST-Centre for Policy Research, Chandigarh (http://cpr.puchd.ac.in/) to highlight the academic excellence available in the 29 institutions of higher learning and National research laboratories located in and around Chandigarh. It has resulted in the creation of 3 dedicated Industry-Academia clusters i.e. Life Sciences Cluster, IT-Cluster and Medical Device Innovation Cluster, culminating into many Industry-Academia R&D linkages.

Amongst many R&D tax incentives offered by the government, most favoured incentive is 150% weighted tax deduction on R&D expenditure (OECD, 2016 & 2015; PwC 2017). Maximum tax rebate was enjoyed by Dr Reddy's Laboratories (Rs 1,64,418 lakhs), Aurobindo Pharmaceuticals [Rs 1,57,304 lakhs) and Glenmark Pharmaceuticals (Rs 1,18,813 lakhs). These tax rebates amount to 20-40% of their R&D expenditure, which are significant. The 200% weighted super deduction on R&D expenditure incurred by the pharmaceutical companies since the 1980s has strongly boosted the R&D engagements of companies like Sun Pharmaceuticals, Ranbaxy, Wockhardt, Dr Reddy and Biocon (Clapper, 2014). The drop down of tax deductions to 150% by the GoI has strongly disappointed the industrial sector as it is a major hit back for large R&D spending companies (Rajagopal, 2016). It was further reported that big pharma units such as Dr Reddy, Lupin, Sun Pharmaceuticals and Wockhardt have welcomed the recent introduction of 10% tax rebate on the royalty earning from global patent filling but were strongly disappointed by reduction in weighted tax deduction from 2017-18 onwards which will be eventually phased out by 2020 (Rajagopal, 2016). These units are expanding their business by filing more and more new drug approvals and are subjected to high-risk high-cost R&D

programmes which require greater government support to expand. The Indian Pharmaceutical Alliance (IPA) has solicited GoI to prioritize the innovation incentive policy framework for pharma manufacturers in the country's upcoming budget.

Jaisinghani (2016) and others (Sharma, 2011; Qiu, 2014; Lee and Choi, 2015; Akkari *et al*., 2016; Dixit and David, 2016; Deloitte, 2017; PwC 2017) examined the importance of R&D intensity on the firm productivity of pharmaceutical industries and reported a positive relationship between R&D investments and profitability of the pharma units.

It was also observed in the current study that the R&D investments in pharma units from 2005 to 2016 have no positive relationship with R&D output of the units which was calculated by the number of research publications, patents, products and processes generated and commercialized by the pharma units. One of the reasons might be the amendment in 2005 of Indian Patent Act 1970 that initially did not promote the product patent for pharmaceutical products. Under the TRIPS agreement big change was observed in pharmaceutical industry as the product patent for new drugs was made possible under Indian Patent Act Amendment 2005 (Bedi *et al*., 2013). The process of generating patentable drug molecules and other pharma associated products/technologies require heavy R&D investments and long time periods (10-15 years) for regulatory approvals and reviewing. Out of 10 prospect molecules its only one molecule that actually passes all the regulatory norms of pharmaceuticals under clinical trials, therefore hit ratio of R&D products to actually enter into the pharmaceutical market is very limited. This might be reason that pharmaceutical firms invest heavily on R&D but it is not reflected in terms of R&D output as for output to be delivered during the requirement of 10-15 years time period required. Therefore, R&D investments made during the time period of 2005-2016 by pharma industry set, considered in this study, might not have generated the expected output in this specific period but the generated technologies will materialize in the coming years. Additionally, as India signed TRIPS agreement in 1994 that made Indian companies enter into product patent regime from 1 Jan 2005 indicating that the majority of the industry units started their R&D initiative and R&D

allocation on the considerable note from 2005 onwards and to generate suitable outcomes of the R&D activities at least 10-15 years time period is required.

Conclusions

- Only a miniscule of pharmaceutical industries in India is DSIR recognized and thus eligible for fiscal R&D incentives. Out of 87 DSIR recognized pharma firms, 41% are large scale, 45% medium scale and 14% small scale units. Majority of DSIR recognized pharma industries are localized in the central and southern regions of India.
- Most of the pharmaceutical firms are availing R&D tax incentives and only a few are utilizing funding support, in form of grants and loans from GoI, for research activities.
- In India, the fiscal benefits provided to pharma industries are based on one-size fit all strategy.
- Pharma sector of India has welcomed the government measures to launch of National pharma mission, 100% FDI approvals, strengthen in patent regime and increased funding support. However, reduction in weighted tax deduction has disappointed Indian pharma units.
- The impact of R&D investments on the financial profitability of the firms was found to be significant and positively correlated. The increase in R&D investments does not match up with R&D outputs such as patents, publications, products and processes and technologies commercialized by the pharma units. However, it is not surprising as pharma R&D requires huge amount of finances as well as long gestation period (10-15 years) to bring up new product in the market.

In order to address the above mentioned remarks on incentivization of R&D of Indian pharma sector, Indian government can draw relevant lessons from other developed economies which are a) in order to stimulate small-scale industries in India, there is a greater need to introduce financial supporting programmes on the lines of ‘Small Business Innovative Research Programme’ and ‘Small Business Technology Transfer Programme’ of USA; ‘Central Innovation Programme for

SMEs' of Germany and 'Technology Platform Initiatives' of U.K; b) in the countries like S. Korea, Japan and U.K, R&D tax incentives have been introduced as per the scale of the industrial unit (large scale, medium scale and small scale) and are paying more dividends. It is suggested that India may adopt such strategy and c) to support R&D investments and R&D output generation, Indian government may provide special incentives for the angel investors to participate in research funding as practiced in U.K. Moreover, Indian government can support activities undertaken by pharma units like patent protection and maintenance, technology conceptualization and commercialization as implemented in countries like China, S. Korea and Japan.

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