National Research Journal of Business Economics
Volume No: 11, Issue No: 1, Year: 2024 (January- June)
PP: 25-41
ISSN No: 2349-2015
Peer Reviewed & Refereed Journal
National Research Journal

# TECHNICAL EFFICIENCY OF INDIAN PHARMACEUTICAL INDUSTRY IN THE NEW PATENT REGIME

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## ABSTRACT

The present paper endeavors to analyse the inter-firm variations in technical efficiency of Indian pharmaceutical industry during the pre-TRIPS and post-TRIPS period. In view of achieving the above objective, data for thirty major Indian pharmaceutical firms has been culled out from the various reports of the Centre for Monitoring Indian Economy (CMIE) over the period 1991 to 2018. The Data Envelopment Analysis (DEA) has been used to compute the technical efficiency and scale efficiency scores of Indian pharmaceutical firms. The empirical result reveals that the average inefficiency to the tune of 11.11 percent has been observed in Indian pharmaceutical industry during the entire study period, whereas it has been found that the Post-TRIPS period has experienced a set-back as the average OTE has declined from 90.8 percent during the pre-TRIPS period to 85.2 percent during the post-TRIPS. Therefore, during the post-TRIPS period the overall technical inefficiency has observed to be 14.8 percent. The result shows that the managerial inefficiency (i.e., pure technical inefficiency) is the dominant source, whereas scale inefficiency is relatively scant source of technical inefficiency in Indian pharmaceutical industry. It can be inferred that the TRIPS agreement has observed to be adversely affected the efficiency trends and thus, failed to exert any positive impact on the efficiency of Indian pharmaceutical industry.

**Keywords:** Malmquist Productivity Index, Pharmaceutical Industry, TRIPS, Data Envelopment Analysis

## INTRODUCTION

The Indian pharmaceutical sector has to come a long way, from being a small player in 1970, to becoming a prominent provider of healthcare products, meeting almost 95 per cent of the country‘s pharmaceutical needs today. In the era of globalization, India has allowed the implication of both the process and product patent under the TRIPS agreement and it was assumed that the introduction of the amendment to the Patent Act (TRIPS) .i.e. process patent as well as product patent leads to hamper the growth of the Indian pharmaceutical industry because it would no longer be able to manufacture by reverse engineering or export drugs whose product patents are in effect. However, contrary to the dark side, the Indian pharmaceutical industry has been rapidly growing in the post-TRIPS period. In view of the TRIPS Agreement and impending changes to the Patent Act of 1970, the Indian pharmaceutical industry is pursuing a new business model where Indian pharmaceutical companies are increasing their investment in R&D, they are increasing exports of generic drugs both to unregulated markets and regulated markets (Sato and Kamike, 2005).

The origin of the modern Indian pharmaceutical industry was commenced by the eminent chemist Prafulla Chandra Ray, when he established Bengal Chemicals & Pharmaceutical Works in 1901 in Kolkata. However, during the colonial period and till, 1970 the Pharmaceutical Industry was dominated by Multinational corporations (MNCs). After the independence, some Public Sector manufacturing firms were established including

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'Hindustan Antibiotics Ltd, 1954, Hindustan Organic Chemicals and Indian Drug & Pharmaceutical Ltd, 1962, but all these establishments could not resist the dominance of foreign companies. The introduction of patent Act, 1970 seems to act as silver lining for the Indian pharmaceutical industry. With the implementation of TRIPS regulations from 2005, there is a tough competition for the global market share. "India has had an efficient pharmaceutical industry which has been making affordable drugs not just for the Indian markets but has also been exporting them to the world but off late, been facing rising FDA scrutiny for quality. Moreover, besides offering greater opportunities for the output growth of Indian pharmaceutical industry globalisation and TRIPS agreement has also posed some crucial challenges which may be viewed as the problems from the perspective of the growth of Indian pharmaceutical industry. Therefore, the introduction of new patent regime (TRIPS Agreement) under the aegis of WTO, the Indian pharmaceutical industry will have to invest in the research and development activities to upgrade its technology, adopt modern production and marketing process and efficient managerial practices along with an improvement in the quality of its products to become more competitive and resource efficient at global level. With the implementation of TRIPS in 2005 ,the Research and Development initiatives has gone up to compete with global players in the field of innovation and to generate new technology. Despite having the comparative cost advantage the intensity of R & D in India is very low. According to an estimate, India attracted merely $ 0.8 bn in pharmaceutical research in 2011, whereas $38 bn and $36 bn was spent by US and Europe respectively. On the one hand New Patent regime is a major challenge for the Indian pharmaceutical industry and on the other hand it creates opportunities for Indian pharmaceutical industry to compete in the global market. Further, keeping in view the challenges and opportunities, the Indian pharmaceutical industry intends to improve efficiency, productivity and global competitiveness as these has been recognized as an important driver of economic growth.

The Indian pharmaceutical industry has grown at an estimated compound annual growth rate (CAGR) of 13 percent during 2009-2014 and also it is expected to grow at CAGR of 12 percent during 2012-2020 (National Pharmaceutical Pricing Policy, 2012 & Drugs Price Control Order, 2013). Due to the TRIPs obligations the Indian pharmaceutical industry requires to improve its efficiency and productivity for a sustained long run growth and to become cost effective to compete with the MNCs of the pharmaceutical products. "It has been well acknowledged fact that the efficient production operations and the optimal and productive use of the available resources given the existing technology, is a pre-requisite to achieve higher productivity levels in input usage and sustained economic growth. If the firms are not making best use of the existing technology, improving their technical efficiency is usually a more cost effective than introducing new technology to achieve sustainable output growth. However, if the firms are reasonably technically efficient then an increase in productivity requires new technology to shift the production function upward" (Neogi and Ghosh, 1994). "The concept of technical efficiency is intrinsically related to the estimation of a production frontier since efficiency measures can only be defined with respect to a benchmark, i.e., an ideal level of performance. Technical efficiency refers to a firm's ability to transform physical inputs to output(s) relative to the best-practice frontier. In other words, given current technology, there is no wastage of inputs whatsoever in producing the given quantity of output(s). A technically efficient firm would be one that produces the maximum possible output(s) from a given set of inputs or one that produces a certain level of output(s) with the minimum amount of inputs. A technically efficient firm operates at the best-practice frontier and will attain efficiency score equal to 1, whereas, the firm operating beneath the

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best-practice levels is deemed to be technically inefficient and its efficiency score lies between 0 and 1. Further, technical efficiency is affected by the factors including the scale or the size of the operations, managerial practices, ownership structure and regulatory environment" (Abbott and Doucouliagos, 1999).

Therefore, the objective of the present study is to analyze the technical efficiency of Indian pharmaceutical industry. The present paper has exhaustively corroborate the theoretical and empirical findings of the Indian pharmaceutical industry at the disaggregate level. For this purpose the paper has been divided into three sections. Section I deals with the sources of the data and construction of the relevant input and output variables, and also includes the theoretical underpinnings of the technical efficiency and discusses the methodology to compute economic, technical and scale efficiencies, where as the Section II discusses the empirical results pertaining to the technical efficiency of Indian pharmaceutical industry. The last section conclude the main findings and provide some significant policy implication.

## SECTION I

## DATABASE AND METHODOLOGY

In this section, an attempt has made to outline the database, concept and methodology to work out the technical efficiency of Indian pharmaceutical industry .The present study confined to period 1991 to 2018 and the cross sectional data for 30 major Indian pharmaceutical firms have been culled out from the various reports of Centre for Monitoring Indian Economy (CMIE),Economic survey of India, Annual Survey of Industries . For the analysis purpose the entire study period (1991 to 2018) has been divided in to two parts .i.e. pre-TRIPS (1991 to 2004) and post-TRIPS (2005 to 2018). In the present paper three inputs has been considered .i.e. net fixed assets, raw material , total expenses and one output .i.e. net sales .The explanation of these four variables has been given as follow ;

1. Net Sales: Sales are estimated as the product of the production and the average unit value of sales of the sample firm and the Net sales derived by deducting goods returned, allowances and discount from the gross amount received from sales.
2. Raw material: It represents the total delivered value of all items of raw materials, components, chemicals, packing materials and stores which actually enter into the production process of the factory during the accounting year. It also includes the cost of all materials used for the construction of building etc. for the factory's own use .It, however, excludes all intermediate products consumed during the accounting year. Intermediate products are those products, which are produced by the factory but are subject to further manufacturing.
3. Total expenses: Money spent or cost incurred in an organization's efforts to generate revenue, representing the cost of doing business .Expenses may be in the form of actual cash payments (wages and salaries),payment for depreciation , interest payments etc
4. Net Fixed Assets: It is the purchase price of all fixed assets (Land, buildings, equipment, machinery, vehicles, leasehold improvements) less accumulated Depreciation, i.e. effectively property, plant and equipment after depreciation. It is however defined as Total Assets - Total Current Assets - Total Intangibles & Goodwill.

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## TECHNICAL EFFICIENCY (CONCEPTUAL FRAMEWORK) AND ITS MEASUREMENT

The technical efficiency of the firm is their capacity and willingness to produce maximum output with given technology and inputs. The efficiency as the ratio of observed output to the maximum potential output that can be attained from given inputs and efficiency comprises of technical efficiency, scale efficiency and allocative efficiency. (Farell 1957). If a decision making unit's actual output is below the maximum potential output, the shortage is regarded as an indicator of inefficiency. Efficiency can be divided into intra-and inter-firm measures, the intra firm involves measuring the firm's own production potential by computing the productivity level over time, relative to a firm-specific highest level of productivity, whereas the inter firm measures the performance of a particular firm relative to its best counterpart(s) available in the industry. "The theoretical consideration of technical efficiency has existed in the economic literature since Koopmans (1951) who defined technical efficiency as a feasible input/output vector where it is technologically impossible to increase any output (and/or reduce any input) without simultaneously reducing another output (and/or increasing any other input). Debreu (1951) and later Farrell[1] (1957) developed input-based indices of technical efficiency, measured as the maximum equi-proportional reduction in all inputs consistent with equivalent production of the observed output.

To be precise, the concept of technical efficiency refers to the producer's ability to avoid the waste of the resources by producing as much output as input usage allows, or by using as little input as output production allows. Simply, technical efficiency is a measure of how well the inputs are converted into output(s) by the production process" (Avkiran, 2006). Technical efficiency can be defined as the ability to produce the outputs or services with a minimum level of resources required (see Avkiran (2006) for detailed discussion). Technical efficiency is defined as relative productivity over time or space, or both. In general, a technically efficient firm would be one that produces the maximum possible output(s) from a given set of inputs or one that produces a certain level of output(s) with the minimum amount of inputs. Thus, technical efficiency refers to a firm's ability to transform physical inputs to output(s) relative to the best-practice frontier. "The failure of firms to produce at the best-practicing frontier which can be called as production inefficiency"(Hicks: 1935, Debreu: 1951, Farrell: 1957).

The concept of technical efficiency is closely associated with 'production frontier' and the 'cost frontier' in the context of theoretical economics. The production frontier refers to the set of maximum output with given inputs while the cost frontier indicates the set of minimum inputs given the different levels of outputs. The efficiency based on the assumption of (CRS) Constant Return to Scale provides a measure of Overall Technical efficiency (OTE), whereas the assumption of (VRTS) Varying Return to Scale provides a measure of Pure Technical Efficiency (PTE). The Pure technical efficiency refers to the proportion of technical efficiency which is attributed to the efficient conversion of inputs into output, given the scale size. Further, Scale efficiency refers to the ratio of productivity measured when the firm produces at the actual, relative to ideal production size, the Scale Efficiency (SE) can be obtained using the ratio of PTE to OTE. The Scale efficiency reflects the choice of optimum

[1] According to Farrell (1957), the economic (cost) efficiency of a firm consists of two components: *technical efficiency*, which reflects the ability of a firm to obtain the maximal output from a given set of inputs and *allocative efficiency*, which reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices.

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scale of production at which Decision Making Unit (DMU) is operating. A value of SE equals to one reflects that DMU is operating at most productive scale (CRS), but if the value of Scale Efficiency is less than one than it means DMU operate at sub-optimal scale. "Along with technical efficiency and scale efficiency measures , an another measure of efficiency is allocative efficiency, while allocative efficiency focuses on the costs of production given that information on prices, as well as a behavioral assumption such as cost minimization or profit maximization, has been properly established. It is clear that allocative efficiency is different from technical and scale efficiencies in the sense that the former addresses issues such as costs and profits, while the latter only considers physical quantities and technical relationships. For instance, allocative efficiency in input selection occurs when selection of inputs (e.g., materials, labour and capital) produces a given quantity of output at a minimum cost, given the prevailing prices of the inputs" (Coelli et al., 1998).

## MEASUREMENT OF TECHNICAL EFFICIENCY (DEA: A NON-PARAMETRIC APPROACH):

The present study uses the non parametric frontier (DEA) to measure the technical efficiency .The non parametric frontier approach was first developed by (Debreu 1951) , (Farrel 1957) and later elaborated by Banker, Charnes, and Cooper(1984). " DEA is a data oriented approach for evaluating performance of a set of peer entities called DMUs, whose performance is characterized by multiple measures /indicators"(Zhu,2003). In present study we use CCR (Charnes,Cooper,Rhodes) and BCC (Banker,Charnes, Cooper) model to obtain efficiency at CRS and VRS. DEA is a data oriented approach for evaluating performance of a set of peer entities called DMUs , whose performance is characterized by multiple measures /indicators (Zhu,2003). "In their seminal paper, Charnes, Cooper and Rhodes(1978) developed a 'data oriented' method based on linear programming technique and coined it as Data Envelopment Analysis (DEA) for estimating the relative technical efficiency of a set of peer entities called decision making units (DMUs)"[2]. Therefore, "The technique of DEA was proposed by the Charnes, Cooper and Rhodes (1978) as a mathematical programming technique to evaluate the relative efficiency of various kinds of homogeneous organisational units, which are called decision making units (after this condensed as DMUs), such as hospitals, public schools, public banks, etc. DEA is useful to asses the relative effectiveness among DMUs having multiple inputs and multiple outputs. DEA is useful in cases where DMUs input-output transformation relationships are not well established.

**CCR and BCC Models:** In DEA models, we evaluate *n* DMUs, where each DMU takes *m* different inputs to produce *s* different outputs. The essence of DEA models in measuring the efficiency of productive unit $DMU_s$ lies in maximizing its efficiency rate. However, subject to condition that the efficiency rate of any other units in the population must not be greater than one i.e. the weights of inputs and outputs must be greater than zero. Such a model is defined as a linear divisive programming model:

$$\text{Maximise} \qquad \frac{\sum_i u_i y_{iq}}{\sum_j v_j x_{jq}} \qquad (1.1)$$

[2] Throughout the study and consistent with DEA terminology, the term 'decision making unit' or 'DMU' will refer to the individuals in the evaluation group. In the context of present applications, it will refer specifically to the industrial groups classified at NIC 2-digit level of aggregation.

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Subject to $\frac{\sum_i u_i y_{ik}}{\sum_j v_j x_{jk}} \leq 1$ k=1,2,….,n

$u_i \geq \varepsilon$ i=1,2,…..,s

$v_j \leq \varepsilon$ j=1,2,…..,m

This model can be converted into a linear programming model and transformed into a matrix:

Maximise $\theta$ (1.2)

Subject to $\sum \lambda_j x_{ij} \leq x_{io}$

$\sum \lambda_j x_{rj} \leq \theta y_{ro}$

$\lambda_j \geq 0$

Where, i = 1,2,….,m inputs.

r = 1,2,…..,s outputs.

j = 1,2,…...,n decision making units.

Model (1.2) is often called primary output oriented CCR model (Charnes, Cooper, Rhodes). The main difference between CCR and BCC model lies in their assumption of production technique. As shown in table 1, whereas CCR model produces a constant returns to scale (CRS) envelopment surface, the BCC model produces a variable returns to scale (VRS) envelopment surface. In BCC model, we add one more constraint $\sum \lambda_j = 1$.

**Table 1**

**Representative DEA Models and their Application**

| **Model** | **Envelopment Surface** | **Orientation** |
|---|---|---|
| CCR | CRS | Input Oriented |
| | | Output Oriented |
| BCC | VRS | Input Oriented |
| | | Output Oriented |

*Source:* Lewin and Seiford (1997)

Each model is further broken down by its approach to achieve efficiency. In input orientation models, proportional decrease in the input variables is used as a means to achieve efficiency. In output orientation models, proportional increase in the output variables is used.

The input oriented CCR model can be written as:

Minimise $\phi$ (1.3)

Subject to $\sum \lambda_j x_{ij} \leq \phi x_{io}$

$\sum \lambda_j y_{rj} \geq y_{ro}$

$\lambda_j \geq 0$

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Where, i = 1,2,….,m inputs.

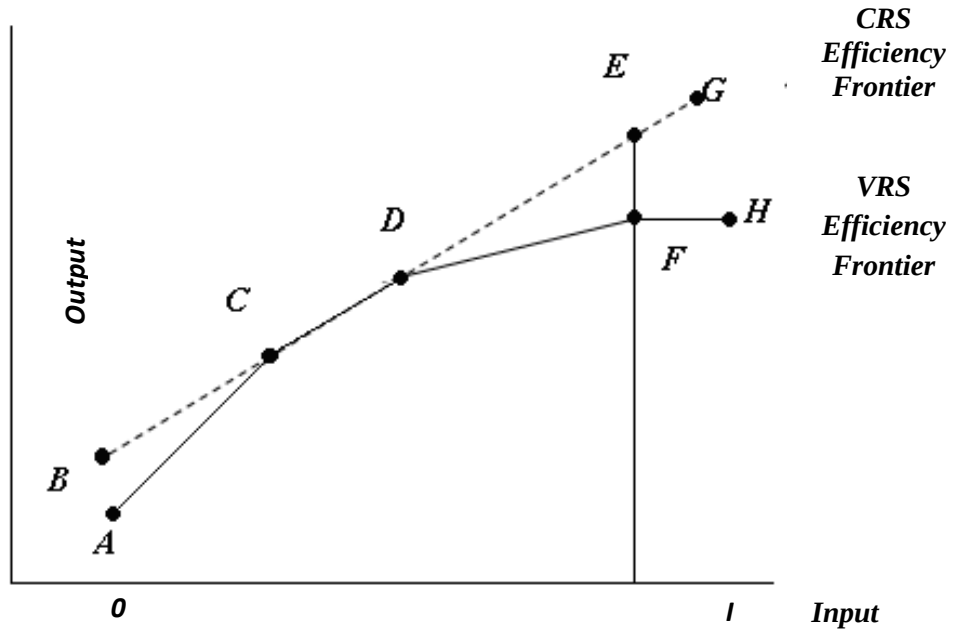
r = 1,2,.....,s outputs.

j = 1,2,.....,n decision making units.

To renovate input oriented CCR model in BCC we add the constraint $\sum \lambda_j = 1$. The VRS DEA is more flexible and envelopes the data in a tighter way than the CRS DEA. Further, Scale Efficiency (SE) scores can be obtained as the ratio of Overall Technical Efficiency to Pure Technical Efficiency (i.e., OTE/PTE). The DMUs, which operate at efficiency frontier assuming VRS technology, may not be operating at efficiency frontier obtained by assuming CRS technology. It can be well-defined using figure 1.

**Figure 1**

**Measuring scale efficiency**




***Source*: Coelli et al. (2005)**

In this figure, we have two efficiency frontiers. Efficiency frontier *BG* assumes CRS technology and efficiency frontier *AH* assumes VRS technology. In facet *CD*, both CRS efficiency frontier and VRS efficiency frontier merged within each other due to which Overall Technical Efficiency (OTE) and Pure Technical Efficiency(PTE) scores are unity consequently scale efficiency score (*=OTE/PTE*) also equal to unity and scale inefficiency (*=1-scale efficiency*) equals to *zero*. At point *F*, decision making unit *s* (i.e. $DMU_s$) is efficient assuming VRS technology but inefficient assuming CRS technology consequently scale efficiency (*=IF/IE*) *=IF*. The segment *EF* is the measure of scale inefficiency.

However, scale inefficiency can be due to the existence of either increasing returns to scale or decreasing returns to scale. This may be determined by calculating an additional DEA problem with non-increasing returns to scale (NIRS) imposed. This can be conducted with $\sum \lambda_j \leq 1$. The output oriented NIRS DEA model now is specified as:

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Maximise $\theta$ (1.4)

Subject to $\sum \lambda_j x_{ij} \leq x_{io}$

$\sum \lambda_j x_{rj} \geq \theta y_{ro}$

$\sum \lambda_j \leq 1$

$\lambda_j \geq 0$

If, NIRS technical efficiency score is unequal to the VRS technical efficiency score, it indicates that increasing returns to scale exists for that region. If they are equal, then decreasing returns to scale apply. Having illustrated DEA intuitively, we may extend the technique to measure economic efficiency using the input prices also. The formulation of LPP to determine economic efficiency can be given as:

$$\min \; w_o' x_o \quad (1.5)$$

Subject to $-y_i + Y\lambda \geq 0,$

$x_i - X\lambda \geq 0,$

$\lambda \geq 0$

where, $w_o'$ is the vector of input prices for the decision making unit (DMU) *o* and $x_o$ represents the input quantities matrix of DMU *o* under evaluation.

**SECTION II**

**RESULTS AND DISCUSSIONS**

In this section the empirical results pertaining to Technical Efficiency (OTE) and its decomposition into Pure Technical Efficiency (PTE) and Scale Efficiency (SE) at different points of time have been discussed**.** Table 2 represents the Overall Technical Efficiency (OTE) for thirty major Indian pharmaceutical firms during the entire study period (1991 to 2018) and two sub-periods, namely, Pre-TRIPS period (1991-2004) and Post-TRIPS period (2005 to 2018). It has been observed that the average OTE score of selected Indian pharmaceutical firms is 0.889 during the entire study period, which suggests that the level of Overall Technical Inefficiency (OTIE= 1-OTE) in selected Indian pharmaceutical firms has been observed to the tune of 11.11 percent. Therefore, it can be inferred that the Indian pharmaceutical firms can reduce its input resources by 11.11 percent without changing the level of output by reallocating its inputs resources.

The introduction of rigorous New Patent Act (TRIPS agreement) has amended the Patent Act of 1970 first in 1995, and subsequently in 2005, thereby paving the way for process and product patenting, as it cause a significant structural shift in the governments' policy for patenting activities in Indian pharmaceutical industry. Thus, in order to analyse the impact of the TRIPS agreement the entire study period has been bifurcated into two sub-periods: i) Pre-TRIPS period from 1991 to 2004 and ii) Post TRIPS period from 2005 to 2018. The empirical analysis reveals that Post-TRIPS period has experienced a set-back as the average OTE score has fallen from 0.908 during Pre-TRIPS period to 0.852 in the Post-TRIPS period, therefore, the OTE for Indian pharmaceutical industry has declined from 90.8 percent in pre-TRIPS period to 85.2 percent in post-TRIPS period indicating a decline in OTE by

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6.16 percent in the post-TRIPS period. During the post-TRIPS period OTIE has observed to be 14.8 percent, which suggests that the Indian pharmaceutical firms can reduce its input resources by 14.8 percent without changing the level of output by reallocating its inputs resources. Table 2 also provides the estimates of OTE for the individual selected Indian pharmaceutical firms, the results found that during the entire period of study, average OTE scores range between minimum of 0.684 for Ambalal Sarabhai Enterprises Ltd. and maximum of 0.982 for Abbot India Ltd. It is to note that all the selected Indian pharmaceutical firms has experienced the OTIE during the entire study period. Moreover, inter firm comparison of OTE has found that the Abbot India Ltd has experienced the highest OTE score (0.982) during the entire study period, which is followed by Novartis India Ltd. (0.981), Wyeth India Ltd. (0.977) and Organon India Pvt. Ltd. (0.963), whereas the Ambalal Sarabhai Enterprises Ltd. is the most laggard firm and has lowest OTE score to the tune of 0.684, which has been followed by Morepen laboratories Ltd. (0.751), Lyka Labs Ltd. (0.760) and Kopran Ltd. (0.775). It has been observed that nineteen firms are operating with above average OTE score during the entire study period. The comparative analysis of average OTE between two distinct regulatory phases (Pre-TRIPS and Post-TRIPS) provides that the nineteen Indian pharmaceutical firms has experienced the declining trends of the average OTE during the Post-TRIPS period relative to what has been observed during the pre-TRIPS period. Further, the

**Table 2: Comparison of Inter-Firm Variations in Overall Technical Efficiency (OTE) of Indian pharmaceutical industry during Pre-TRIPS and Post-TRIPS period.**

| Companies | Entire period (1991-2018) | Pre-TRIPS (1991-2004) | Post-TRIPS (2005-18) | PTGR (%) |
|---|---|---|---|---|
| Aurobindo Pharma Ltd. | 0.898 | 0.928 | 0.839 | -9.59 |
| Abbott India Ltd. | 0.982 | 0.981 | 0.984 | 0.30 |
| Alembic Ltd. | 0.854 | 0.867 | 0.829 | -4.38 |
| Ambalal Sarabhai Enterprises Ltd. | 0.684 | 0.769 | 0.514 | -33.15 |
| Amrutanjan Health Care Ltd. | 0.895 | 0.937 | 0.812 | -13.34 |
| Astrazeneca Pharma India Ltd. | 0.926 | 0.908 | 0.962 | 5.94 |
| Cipla Ltd. | 0.923 | 0.925 | 0.918 | -0.75 |
| Dr. Reddy'S Laboratories Ltd. | 0.934 | 0.958 | 0.884 | -7.72 |
| East India Pharmaceutical Works Ltd. | 0.918 | 0.960 | 0.834 | -13.12 |
| F D C Ltd. | 0.918 | 0.919 | 0.915 | -0.43 |
| Glaxosmithkline Pharmaceuticals Ltd. | 0.945 | 0.921 | 0.994 | 7.92 |
| Ipca Laboratories Ltd. | 0.879 | 0.883 | 0.869 | -1.58 |
| J B Chemicals & Pharmaceuticals Ltd. | 0.931 | 0.948 | 0.898 | -5.27 |
| Kopran Ltd. | 0.775 | 0.829 | 0.668 | -19.42 |
| Lupin Laboratories Ltd. [Merged] | 0.878 | 0.869 | 0.896 | 3.10 |
| Lyka Labs Ltd. | 0.760 | 0.789 | 0.703 | -10.89 |
| Merck Ltd. | 0.912 | 0.907 | 0.923 | 1.76 |
| Morepen Laboratories Ltd. | 0.751 | 0.848 | 0.556 | -34.43 |

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| | | | | |
|---|---|---|---|---|
| Novartis India Ltd. | 0.981 | 0.972 | 1.000 | 2.88 |
| Organon (India) Pvt. Ltd. | 0.963 | 0.994 | 0.902 | -9.25 |
| Pfizer Ltd. | 0.940 | 0.973 | 0.874 | -10.17 |
| Piramal Enterprises Ltd. | 0.856 | 0.901 | 0.766 | -14.98 |
| Ranbaxy Laboratories Ltd. | 0.851 | 0.889 | 0.775 | -12.82 |
| Sun Pharmaceutical Inds. Ltd. | 0.905 | 0.957 | 0.800 | -16.40 |
| Sanofi India Ltd. | 0.864 | 0.861 | 0.870 | 1.04 |
| T T K Healthcare Ltd. | 0.891 | 0.899 | 0.875 | -2.66 |
| Twilight Litaka Pharma Ltd. | 0.830 | 0.826 | 0.838 | 1.45 |
| U S V Ltd. | 0.943 | 0.936 | 0.956 | 2.13 |
| Unichem Laboratories Ltd. | 0.906 | 0.897 | 0.924 | 3.01 |
| Wyeth Ltd. | 0.977 | 0.976 | 0.980 | 0.40 |
| Total/Mean# | 0.889 | 0.908 | 0.852 | -6.16 |

Note: i) # represent the average of 30 pharmaceutical firms of India; ii) PTGR refers Growth of Overall Technical Efficiency between pre-TRIPS and post-TRIPS periods.

**Source: Author's Calculations**

decline in OTE during the post-TRIPS period has more pronounced for the Morepen laboratories Ltd (-34.43 percent), Ambalal Sarabhai Enterprises Ltd. (-33.15 percent) and Kopran Ltd. (-19.42 percent), whereas Glaxosmithkline Pharmaceuticals Ltd has registered the maximum positive growth of OTE during the post TRIPS period to the tune of 7.92 percent. Further the average OTE for all the selected firms has declined by 6.16 percent during the post-TRIPS period. Therefore, the new patent Act has imparted a significantly negative impact on the OTE of Indian pharmaceutical industry. The analysis of OTE score of thirty major Indian pharmaceutical firms represents a variation in the during the pre-TRIPS and post-TRIPS period and characterizes an immense potential for the pharmaceutical firms to reduce its operating cost and thereby enhance its Overall Technical efficiency. Thus, such a severe decline in technical efficiency demands the analysis of the sources of technical inefficiency in Indian pharmaceutical industry.

**Sources of Technical Inefficiency**

In order to examine the causes of OTIE in Indian pharmaceutical industry, the measure of OTE has been decomposed into two non-additive mutually exclusive components, namely pure technical efficiency (PTE) and scale efficiency (SE). It is significant to note that in contrast to OTE measure, the PTE measure is devoid of scale effect. Therefore, all inefficiency reflected from PTE score directly results from managerial sub-performance. Keeping aside the scale effect, the PTE score reflects a sort of managerial efficiency, i.e., the ability of management to convert the resources into output(s) and thus, can be treated as an index of managerial quality. On the other hand, the SE measure indicates whether the Indian pharmaceutical firms in question is operating at most productive scale size (MPSS) or not? Therefore, the PTE is, a measure of managerial performance, as the SE reflects the choice of optimum scale of production. The, PTE is devoid of scale effect and can be measured subject to the assumption of the variable returns to scale. The PTE scores have been obtained by running the BCC model to estimate cumulative frontier for each pharmaceutical firm separately. Table 3 provides inter-firm variations in the pure technical efficiency (PTE) of Indian pharmaceutical industry. It has been noted that in each year, average PTE in Indian pharmaceutical industry is to the tune of 93.3 percent per annum. This implies that 6.7 percentage points of 11.11 percent of average OTIE is due to inappropriate management

ISSN No: 2349-2015
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practices that are being adopted in the production process of Indian pharmaceutical products. Thus, the remaining inefficiency is caused by the scale factor. Hence, it is evident from these facts that the managerial inefficiency is major source of OTIE in Indian pharmaceutical industry. The decomposition of OTE into two aforementioned components for the two distinct sub-periods (pre-TRIPS and post-TRIPS) delineates a precipitous decline of PTE by 2.44 percent during the post-TRIPS period. The PTIE has observed to be 5.9 percent during the pre-TRIPS period which has been increased to 8.2 percent during the post-TRIPS period. Therefore, the direct connotation of this result is that the implementation of TRIPS agreement has worsen the managerial efficiency of the Indian pharmaceutical industry. It has been observed that only one firm .i.e. Glaxosmithkline Pharmaceuticals Ltd. have been observed benchmark firm in terms of managerial practice during the entire study period, because the PTE of this firm amounts to unity. The minimum managerial efficiency has been observed for Morepen Laboratories Ltd. Moreover, during the post-TRIPS period, six firms namely Abbott India Ltd., Amrutanjan Health Care Ltd., Glaxosmithkline Pharmaceuticals Ltd., Novartis India Ltd., Organon (India) Pvt. Ltd, and T T K Healthcare Ltd have been observed to be benchmark firms in terms of managerial practice during the post-TRIPS period where the PTE of these firms amounts to unity.

Moreover, SIE has observed to be 4.8 percent during the entire study period, whereas it has been increased from 3.6 percent during the pre-TRIPS period to 7.2 percent during the post-TRIPS, it is , therefore, inferred that SIE of Indian pharmaceutical industry has increased in the post-TRIPS period. Further, the analysis of scale efficiency reflects that, scale inefficiency varies from the minimum of zero percent for Novartis India Ltd to maximum of 36.7 percent for the Ambalal Sarabhai Enterprises Ltd.. Thus there exists a huge variation in scale efficiency among thirty major Indian pharmaceutical firms. It can be concluded from the empirical results that the Indian pharmaceutical firms firms may able to decrease its inputs by 11.1 percent beyond its practice target under VRS, if it were to operate at CRS. (Shivdas 2012), "emphasized the need for efficient utilization of resources so as to have sustainable growth of firms". (Mahajan.et.al. 2014) "estimated technical efficiency, slack, and input/output targets of fifty large Indian Pharmaceutical firms for 2010-11, reported that the inefficiency in firms was either due to inefficient managerial performance or low scale utilization". Further, the global crisis has not left the Indian pharmaceutical sector unscathed from its impacts. "A shrinking demand for the Indian exports from the destination countries along with a fluctuation of Rupee vis-à-vis the US Dollar may also adversely affect the growth prospect of Indian Pharmaceutical sector"(Tripathy , yadav and Sharma). In the era of new patent regime, the Indian pharmaceutical firms has to compete with the stringent business standards of the global market, which require the efficient utilization of resources. Moreover, in the new patent regime, a large amount of investment in Research and Development expenditure is required to improve the efficiency of the Indian pharmaceutical firms whose performance is sub-optimal. Moreover, the trends of variations in technical efficiency and scale efficiency of thirty major Indian pharmaceutical firms during 1991 to 2011 has been summed up in fig 2.

**Table 3: Comparison of Inter-Firm Variations in Pure Technical Efficiency (PTE) of Indian pharmaceutical industry during Pre-TRIPS and Post-TRIPS period**.

| Companies | Entire period (1991-2018) | Pre-TRIPS (1991-2004) | Post-TRIPS (2005-18) | PTGR (%) |
|---|---|---|---|---|
| Aurobindo Pharma Ltd. | 0.933 | 0.962 | 0.876 | -8.93 |

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|---|---|---|---|---|
| Abbott India Ltd. | 0.996 | 0.994 | 1.000 | 0.60 |
| Alembic Ltd. | 0.876 | 0.888 | 0.852 | -4.05 |
| Ambalal Sarabhai Enterprises Ltd. | 0.821 | 0.803 | 0.856 | 6.60 |
| Amrutanjan Health Care Ltd. | 0.999 | 0.999 | 1.000 | 0.10 |
| Astrazeneca Pharma India Ltd. | 0.947 | 0.936 | 0.968 | 3.41 |
| Cipla Ltd. | 0.969 | 0.959 | 0.988 | 3.02 |
| Dr. Reddy'S Laboratories Ltd. | 0.975 | 0.981 | 0.962 | -1.93 |
| East India Pharmaceutical Works Ltd. | 0.979 | 0.974 | 0.989 | 1.54 |
| F D C Ltd. | 0.931 | 0.936 | 0.921 | -1.60 |
| Glaxosmithkline Pharmaceuticals Ltd. | 1.000 | 1.000 | 1.000 | 0 |
| Ipca Laboratories Ltd. | 0.895 | 0.897 | 0.892 | -0.55 |
| J B Chemicals & Pharmaceuticals Ltd. | 0.941 | 0.957 | 0.908 | -5.12 |
| Kopran Ltd. | 0.840 | 0.857 | 0.807 | -5.83 |
| Lupin Laboratories Ltd. [Merged] | 0.934 | 0.933 | 0.937 | 0.42 |
| Lyka Labs Ltd. | 0.831 | 0.825 | 0.845 | 2.42 |
| Merck Ltd. | 0.920 | 0.915 | 0.930 | 1.63 |
| Morepen Laboratories Ltd. | 0.809 | 0.905 | 0.617 | -31.82 |
| Novartis India Ltd. | 0.997 | 0.996 | 1.000 | 0.40 |
| Organon (India) Pvt. Ltd. | 0.998 | 0.997 | 1.000 | 0.30 |
| Pfizer Ltd. | 0.957 | 0.983 | 0.905 | -7.93 |
| Piramal Enterprises Ltd. | 0.891 | 0.935 | 0.803 | -14.11 |
| Ranbaxy Laboratories Ltd. | 0.993 | 1.000 | 0.980 | -2.00 |
| Sun Pharmaceutical Inds. Ltd. | 0.927 | 0.967 | 0.849 | -12.20 |
| Sanofi India Ltd. | 0.895 | 0.898 | 0.889 | -1.00 |
| T T K Healthcare Ltd. | 0.950 | 0.926 | 1.000 | 7.99 |
| Twilight Litaka Pharma Ltd. | 0.950 | 0.985 | 0.881 | -10.55 |
| U S V Ltd. | 0.949 | 0.940 | 0.968 | 2.97 |
| Unichem Laboratories Ltd. | 0.913 | 0.904 | 0.931 | 2.98 |
| Wyeth Ltd. | 0.982 | 0.983 | 0.981 | -0.20 |
| Total/Mean# | 0.933 | 0.941 | 0.918 | -2.44 |

Note: i) # represent the average of 30 pharmaceutical firms of India; ii) PTGR refers Growth of Pure Technical Efficiency between pre-TRIPS and post-TRIPS periods.

**Source: Author's Calculations**

**Table 4: Comparison of Inter-Firm Variations in Scale efficiency (SE) of Indian pharmaceutical industry during Pre-TRIPS and Post-TRIPS period.**

| Companies | Entire period (1991-2018) | Pre-TRIPS (1991-2004) | Post-TRIPS (2005-18) | PTGR (%) |
|---|---|---|---|---|
| Aurobindo Pharma Ltd. | 0.962 | 0.964 | 0.958 | -0.62 |

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|---|---|---|---|---|
| Abbott India Ltd. | 0.986 | 0.987 | 0.984 | -0.30 |
| Alembic Ltd. | 0.976 | 0.977 | 0.973 | -0.40 |
| Ambalal Sarabhai Enterprises Ltd. | 0.847 | 0.955 | 0.633 | -33.71 |
| Amrutanjan Health Care Ltd. | 0.896 | 0.938 | 0.812 | -13.43 |
| Astrazeneca Pharma India Ltd. | 0.976 | 0.967 | 0.993 | 2.68 |
| Cipla Ltd. | 0.953 | 0.964 | 0.930 | -3.52 |
| Dr. Reddy'S Laboratories Ltd. | 0.957 | 0.976 | 0.919 | -5.84 |
| East India Pharmaceutical Works Ltd. | 0.937 | 0.985 | 0.843 | -14.41 |
| F D C Ltd. | 0.985 | 0.982 | 0.993 | 1.12 |
| Glaxosmithkline Pharmaceuticals Ltd. | 0.945 | 0.921 | 0.994 | 7.92 |
| Ipca Laboratories Ltd. | 0.981 | 0.984 | 0.974 | -1.01 |
| J B Chemicals & Pharmaceuticals Ltd. | 0.989 | 0.990 | 0.988 | -0.20 |
| Kopran Ltd. | 0.922 | 0.965 | 0.838 | -13.16 |
| Lupin Laboratories Ltd. [Merged] | 0.941 | 0.933 | 0.956 | 2.46 |
| Lyka Labs Ltd. | 0.920 | 0.959 | 0.841 | -12.30 |
| Merck Ltd. | 0.991 | 0.991 | 0.992 | 0.10 |
| Morepen Laboratories Ltd. | 0.921 | 0.936 | 0.890 | -4.91 |
| Novartis India Ltd. | 0.984 | 0.976 | 1.000 | 2.45 |
| Organon (India) Pvt. Ltd. | 0.965 | 0.997 | 0.902 | -9.52 |
| Pfizer Ltd. | 0.982 | 0.989 | 0.968 | -2.12 |
| Piramal Enterprises Ltd. | 0.961 | 0.963 | 0.956 | -0.72 |
| Ranbaxy Laboratories Ltd. | 0.856 | 0.889 | 0.790 | -11.13 |
| Sun Pharmaceutical Inds. Ltd. | 0.974 | 0.990 | 0.943 | -4.74 |
| Sanofi India Ltd. | 0.965 | 0.958 | 0.978 | 2.08 |
| T T K Healthcare Ltd. | 0.939 | 0.972 | 0.875 | -9.97 |
| Twilight Litaka Pharma Ltd. | 0.878 | 0.840 | 0.954 | 13.57 |
| U S V Ltd. | 0.993 | 0.995 | 0.987 | -0.80 |
| Unichem Laboratories Ltd. | 0.991 | 0.991 | 0.992 | 0.10 |
| Wyeth Ltd. | 0.994 | 0.992 | 0.998 | 0.60 |
| Total/Mean# | 0.952 | 0.964 | 0.928 | -3.73 |

ISSN No: 2349-2015
Peer Reviewed & Refereed Journal
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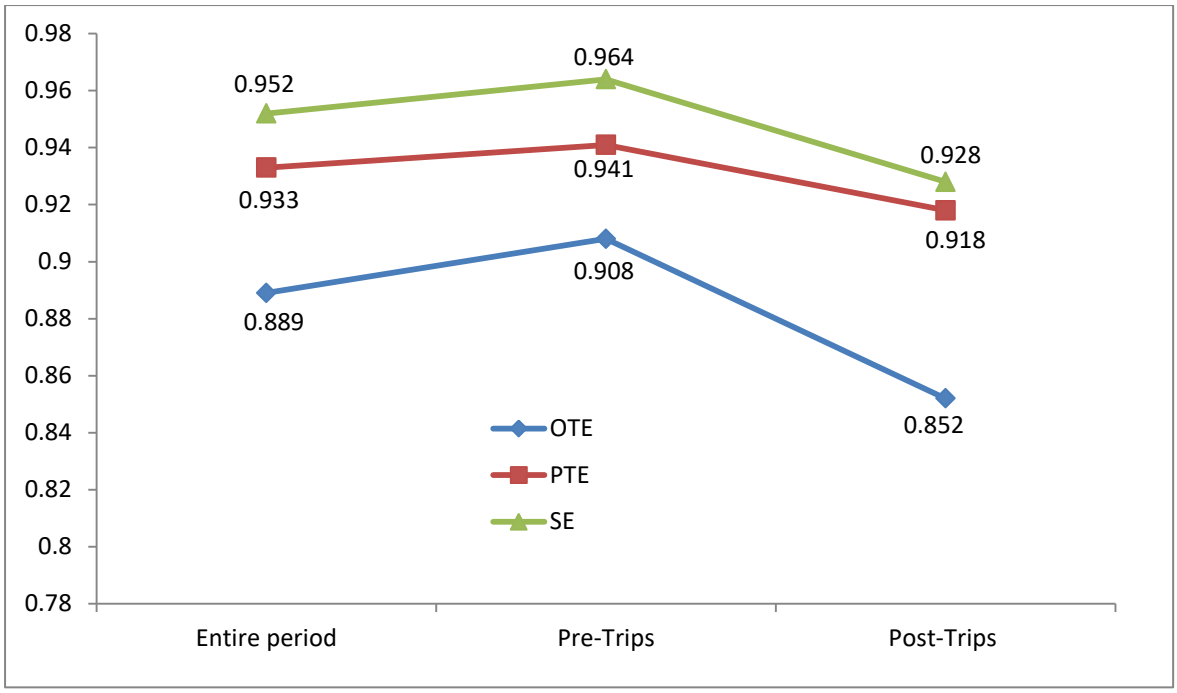
Note: i) # represent the average of 30 pharmaceutical firms of India; ii) PTGR refers Growth of Scale Efficiency between pre-TRIPS and post-TRIPS periods.

**Source: Author's Calculations**

**Fig; 2 Trends of OTE, PTE and SE during the Pre-TRIPS and Post-TRIPS period**




**Source: Author's Calculations**

## SECTION III

## CONCLUSION

The present study endeavors to analyse the inter-firm variations in technical efficiency of Indian pharmaceutical industry during 1991 to 2018. The empirical result shows that **t**he average efficiency level in Indian pharmaceutical industry has found to be 88.9 percent, in other words there exists 11.1 percent technical inefficiency in Indian pharmaceutical industry, which indicates that on an average 11.1 percent more output can be produced in the Indian pharmaceutical industry by using the same bundle of inputs. Further, it has been observed that the dominant source of OTIE is managerial inefficiency and scale inefficiency is relatively less dominating. Moreover, there exists notable variation in the OTE ranging between 98.2 percent and 68.4 percent. It is worth mentioning here that the dominance of managerial inefficiency (i.e., PTIE) as a source of OTIE is a pervasive phenomenon and not limited to a particular firm. The empirical analysis reveals that post-TRIPS period has experienced a set-back as the average OTE score has fallen from 0.908 during Pre-TRIPS period to 0.852 in the post-TRIPS period, therefore the OTE for Indian pharmaceutical industry has declined from 90.8 percent in pre-TRIPS period to 85.2 percent in post-TRIPS period indicating a decline in OTE by 6.16 percent in the post-TRIPS period. The comparative analysis of efficiency measures between pre-TRIPS and post-TRIPS period shows that the implementation of TRIPS agreement has failed to exert any positive impact on the efficiency of Indian Pharmaceutical industry. This is evident from the fact that average efficiency of Indian pharmaceutical industry has observed to be decline in the post-TRIPS

ISSN No: 2349-2015
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period relative to pre-TRIPS period. The inter-firm analysis of OTE depicts that Abbott India Ltd been observed to be the best practice state whereas Ambalal Sarabhai Enterprises Ltd. is worst performer firm of the sample. It has been found that there exists a huge variation in the technical efficiency scores between thirty major Indian pharmaceutical firms. However, the analysis for the sources of technical inefficiency in Indian pharmaceutical industry has observed that, average PTE in Indian pharmaceutical industry is to the tune of 93.3 percent per annum. This implies that 6.7 percentage points of 11.11 percent of average OTIE is due to inappropriate management practices that are being adopted in the production process of Indian pharmaceutical products. Thus the remaining inefficiency is caused by the scale factor. Hence, it is evident from these facts that the managerial inefficiency is major source of OTIE in Indian pharmaceutical industry.

The PTIE has observed to be 5.9 percent during the pre-TRIPS period which has been increased to 8.2 percent during the post-TRIPS period. Therefore, the direct connotation of this result is that the implementation of TRIPS agreement has worsen the managerial efficiency of the Indian pharmaceutical industry. It has been observed that only one firm .i.e. Glaxosmithkline Pharmaceuticals Ltd. have been observed benchmark firm in terms of managerial practice during the entire study period, because the PTE of this firm amounts to unity. Moreover, SIE has observed to be 4.8 percent during the entire study period, whereas it has been increased from 3.6 percent during the pre-TRIPS period to 7.2 percent during the post-TRIPS, it is , therefore, inferred that SIE of Indian pharmaceutical industry has increased in the post-TRIPS period. It can be concluded from the empirical results that the Indian pharmaceutical firms may able to decrease its inputs by 11.1 percent beyond its practice target under VRS, if it were to operate at CRS. (Shivdas 2012), “emphasized the need for efficient utilization of resources so as to have sustainable growth of firms”. (Mahajan.et.al. 2014) “estimated technical efficiency , slack , and input/output targets of fifty large Indian Pharmaceutical firms for 2010-11 , reported that the inefficiency in firms was either due to inefficient managerial performance or low scale utilization”. Further, the global crisis has not left the Indian pharmaceutical sector unscathed from its impacts. A shrinking demand for the Indian exports from the destination countries along with a fluctuation of Rupee vis-à-vis the US Dollar may also adversely affect the growth prospect of Indian Pharmaceutical sector. In the era of new patent regime, the Indian pharmaceutical firms has to compete with the stringent business standards of the global market, which require the efficient utilization of resources. Moreover, in the new patent regime, a large amount of investment in research and development expenditure is required to improve the efficiency of the Indian pharmaceutical firms whose performance is sub-optimal. Further, in addition to the growth challenges, the Indian pharmaceutical industry is currently grappling with a number of issues like delay in chemical trial approval, uncertainty over FDI policy, the New Pharmaceutical Pricing Policy and compulsory licensing , all of which need a speedy resolution. The industry is also facing strict regulation on managerial and quality practices in domestic as well as international market. Moreover, the proposed reduction in corporate tax is expected to lead higher investment, higher growth and more technology transfer in the Indian pharmaceutical sector. In this context, the establishment of Atal Innovation mission to boost the level of Research and Development and innovation in the pharmaceutical sector is a welcome step. In addition to this, the inclusion of the pharmaceuticals sector in the “Make in India” campaign provides a unique opportunity to the industry to push its agenda of R&D, innovation and affordable healthcare for all in the new patent regime.

ISSN No: 2349-2015
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**FUNDING:**

*I declare that no funds, grants, or other support were received during the preparation of this manuscript.*

**Conflict of Interest***:*

*We have no relevant financial or non-financial interests to disclose*

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