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Impact of Institutional Reforms on the Export Efficiency of the Indian Pharmaceutical Industry: A Perspective from the Post-TRIPS Era

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ABSTRACT
The impact of institutional reforms on the performance of various industries in emerging economies has been a significant research focus over the past 40 years. In this study, we examine how these reforms have affected the export efficiency of the Indian pharmaceutical industry since India joined the World Trade Organization (WTO) on January 1, 1995. India was granted a 10-year transition period, ending on December 31, 2004, to fully comply with the Trade-Related Intellectual Property Rights (TRIPS) provisions of the WTO agreement. Consequently, India shifted from a process-patent regime to a product-patent regime starting January 1, 2005. Many researchers and industry experts initially believed that these reforms would hinder the growth of the Indian pharmaceutical industry. However, contrary to these predictions, the industry has leveraged export opportunities in developed and emerging economies worldwide. In this context, we aim to evaluate the export efficiency of the Indian pharmaceutical industry during the post-TRIPS period (2004-2023) using data envelopment analysis (DEA). The findings of our research indicate that the export efficiency of the Indian pharmaceutical industry had improved during 2004-2013 but decreased during 2014-2023.

Keywords: Export efficiency, Indian pharmaceutical industry, Institutional reforms, Post-TRIPs, Transitory-TRIPs.

INTRODUCTION

Previous research in strategic management largely concentrated on assessing corporate performance using only financial metrics, neglecting the role of efficiency measurements in evaluating performance (Chen, Delmas & Lieberman, 2015). Addressing this shortfall can be achieved by employing frontier techniques like data envelopment analysis (DEA) and stochastic frontier analysis (SFA) to measure efficiency (Chen, Delmas & Lieberman, 2015).

While there have been efforts to measure firm efficiency across various sectors, only a few studies (Pusnik, 2010; Saranga, 2007) have looked into export efficiency as a performance metric. This paper seeks to fill this gap by assessing the export efficiency of the Indian pharmaceutical industry (IPI) during the post-TRIPs period (2004-2023). Previous research has examined IPI export performance before 2004, when India was transitioning to comply fully with product patents from process patents (1995-2004). Some studies have focused on the export efficiency of Indian pharmaceutical companies either during the transition period (1995-2004) or the early post-TRIPs phase (2005-2014). Our study uniquely assesses IPI export efficiency over two decades (2004-2023) in the post-TRIPs era.

Figure 1: Trend analysis of average industry sales and export sales of Indian Pharmaceutical Industry (2004-2023)

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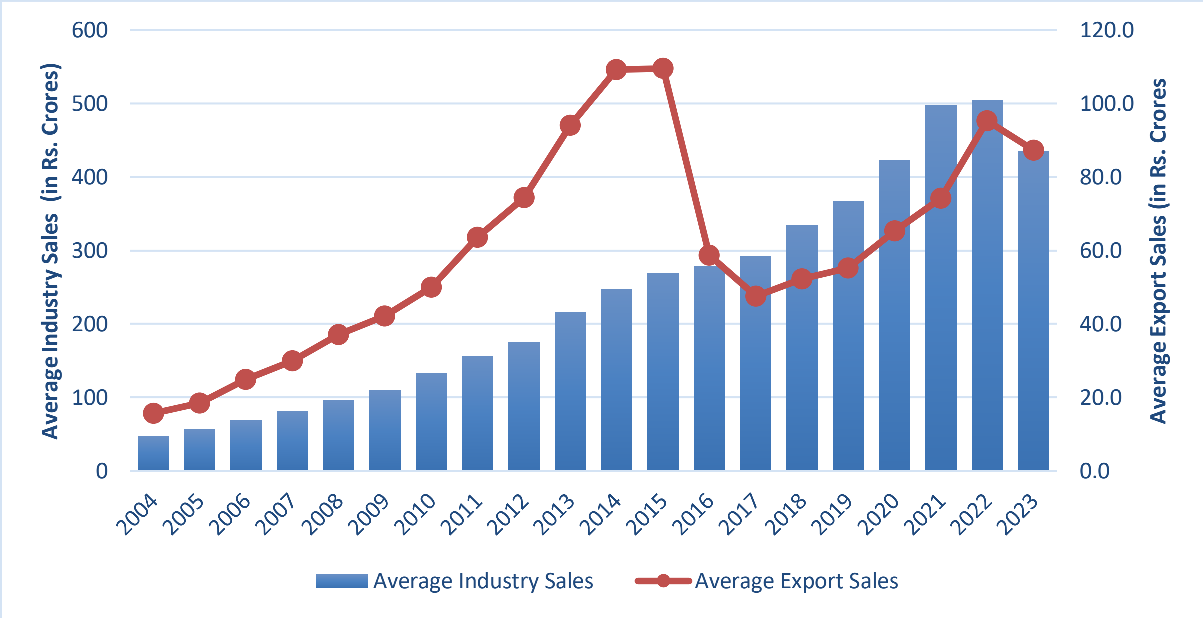

It can be observed from Figure 1 that the average industry sales of the IPI progressively increased till 2015 and exhibited a low growth trend during 2016-2019. This can be due to macro-economic decisions like demonetisation and GST (2016 and 2017 respectively). The average export sales of the IPI during 2016 and 2017 have decreased due to the transition to the new GST regime and the impact of demonetization. The export sales of the IPI have again improved post-Covid period since India had largely been a supplier of pharmaceutical products to many of the countries globally, immediately after the Covid period during 2020-2021.

The Indian Pharmaceutical Industry (IPI) is a notable example of both process and product innovation. Since India's independence in 1947, the IPI has experienced substantial changes over the past eighty years. From 1970 to 1995, India adhered to process patent laws until it became a member of the World Trade Organization (WTO) on January 1, 1995. This research aims to analyze the effect of institutional regulations (patent laws) on IPI export efficiency during the post-TRIPs period using Data Envelopment Analysis (DEA).

Following the variables used in earlier studies (Mahajan, Nauriyal, and Singh, 2014a; Mahajan, Nauriyal, and Singh, 2014b; Rentala, Anand, and Shaban, 2017; Saranga and Phani, 2009), our study measures export efficiency by considering export sales as the output variable. The input variables for the DEA include R&D expenses, raw material imports, employee compensation, and marketing expenses. We assess export efficiency by calculating Constant Returns to Scale Efficiency (CRSTE), Variable Returns to Scale Efficiency (VRSTE), and Scale Efficiency (CRSTE/VRSTE) for the period from 2004 to 2023.

Data Envelopment Analysis (DEA) is used to measure export efficiency. DEA has gained prominence as a tool for evaluating and enhancing performance in manufacturing and service sectors. It has been widely applied in the performance evaluation and benchmarking of various institutions such as schools, hospitals, and bank branches (Charnes, Cooper, Lewin & Seiford, 1994). DEA is a multi-factor productivity analysis model that measures the relative efficiencies of similar decision-making units (DMUs). The term "data envelopment analysis" was introduced by Charnes, Cooper, and Rhodes (1978) with an input-oriented model featuring constant returns to scale (CRS). Banker, Charnes, and Cooper (1984) later introduced the variable returns to scale (VRS) model.

As previously stated, export efficiency is measured by considering export sales as the output. Input factors include R&D expenses, raw material import costs, employee compensation, and marketing expenses. Using DEA, we calculated CRSTE (constant returns to scale technical efficiency) and VRSTE (variable returns to scale technical efficiency). Additionally, Scale Efficiency (CRSTE/VRSTE) was assessed for firms during the transitory-TRIPS and post-TRIPS periods.

THEORETICAL FRAMEWORK AND REVIEW OF LITERATURE

Theoretical Framework

Data Envelopment Analysis (DEA) is a relatively recent "data-oriented" method used to assess the performance of a group of peer entities known as Decision Making Units (DMUs), which transform multiple inputs into multiple outputs. The concept of a DMU is broad and adaptable. In recent years, DEA has been applied in various ways to evaluate the performance of firms in emerging economies engaged in different activities.

DEA has been utilized across numerous fields such as operations research, management control systems, organizational theory, strategic management, economics, accounting and finance, human resource management, and public administration, including assessments of countries and regions. Its minimal assumption requirements make DEA suitable for complex scenarios where other methods struggle due to the intricate (and often unknown) relationships between multiple inputs and outputs of DMUs.

Data Envelopment Analysis (DEA) is based on production theory and linear programming principles. It was introduced in 1978 by Charnes, Cooper, and Rhodes, who demonstrated how to convert a fractional linear efficiency measure into a linear programming (LP) format. This allowed for the evaluation of DMUs based on various inputs and outputs, even when the production function was not known. DEA assesses how efficiently a unit—such as a firm, organization, or agency—uses its resources to produce outputs relative to other units in the dataset.

This non-parametric method solves an LP problem for each DMU, with the weights assigned during this process highlighting the DMU's performance as favorably as possible, while ensuring that no other DMU, under the same weights, exceeds 100% efficiency. Since its introduction in 1978, DEA has been widely recognized as an excellent and user-friendly methodology for modeling operational processes and evaluating performance. Its empirical focus and lack of need for numerous pre-assumed conditions—unlike traditional statistical regression methods—have led to its use in studies of efficient frontier estimation in various sectors, including government, non-profit, regulated, and private sectors. In their foundational study, Charnes, Cooper, and Rhodes (1978) described DEA as a "mathematical programming model applied to observational data" that provides a novel approach for deriving empirical estimates of relations such as production functions and efficient production possibility surfaces, which are central to modern economics. DEA is a non-parametric tool because it does not assume the shape or parameters of the underlying production function. It is a linear programming technique inspired by Farrell’s efficiency measure (1957) used to assess the relative efficiency of different DMUs.

b) Brief Review of Literature

Saranga (2007) analyzed the efficiency of firms within the Indian Pharmaceutical Industry using a multiple objective DEA approach from 1992 to 2002. The study focused on a sample of 44 firms that had continuous data availability for the inputs and outputs considered. Regular inputs included production cost, material cost, and labor cost, while regular outputs were net sales and profit margins. Additionally, R&D expenditure and export sales were treated as special outputs. The results showed that firms with higher export volumes were generally more efficient compared to those with lower export sales.

Saranga (2009) evaluated the operational efficiency of the Indian auto components industry using DEA, with a sample of 50 firms for the year 2003. The inputs for the study were raw material costs, labor costs, cost of capital, and sundry costs, while the output variable was gross income. The analysis revealed that 14 firms were efficient according to the constant returns to scale (CRS) model, whereas 36 firms were deemed inefficient. Using the variable returns to scale (VRS) model, 21 firms were efficient and 29 were inefficient. The study also explored the determinants of efficiency by examining capital employed, average inventory, net working capital cycle, and royalty payments as independent variables, using multiple regression analysis.

Saranga and Phani (2009) investigated the determinants of operational efficiency for 44 Indian pharmaceutical firms using DEA from 1992 to 2002. The study used production and selling costs, raw material costs, and wages and salaries as inputs, while net sales were the output variable. It was found that only 8 of the 44 firms were efficient over the study period. These firms were identified as efficient in at least five out of the eleven years considered, whereas the remaining 36 firms were only efficient in four or fewer years.

Tripathy, Yadav, and Sharma (2013) conducted a comparative study on the efficiency and productivity of the Indian Pharmaceutical Industry during the process patent (2001-02 to 2004-05) and product patent (2005-06 to 2008-09) regimes. The study included 81 large Indian pharmaceutical firms, measuring efficiency with DEA and productivity with the Malmquist Productivity Index (MPI). Domestic and export sales were considered as output variables, while costs for materials, energy, wages, and advertising were inputs. The VRSTE method revealed that 28 firms were efficient during the process patent regime compared to 19 firms in the product patent regime. In terms of scale efficiency, 14 firms were scale efficient during the process patent era, compared to 20 firms in the product patent era. The study concluded that technical efficiency and productivity had improved more during the product patent regime than in the process patent regime.

Mahajan, Nauriyal, and Singh (2014a) analyzed the technical efficiency of the Indian Pharmaceutical Industry using DEA for the period 2010-2011. The study examined 50 firms, with net sales revenue as the output variable and raw material costs, salaries and wages, advertising and marketing costs, and capital usage costs as inputs. The findings indicated that only 9 firms were scale efficient, while the remaining 41 firms were scale inefficient.

Mahajan, Nauriyal, and Singh (2014b) investigated the impact of ownership type on the efficiency of the top 50 Indian pharmaceutical firms using DEA for the period 2010-2011. Input variables included raw material costs, salaries and wages, advertising and marketing expenses, and capital usage costs, with net sales value as the output variable. Of the 50 firms studied, only 9 were found to be overall technically efficient, with 19 being pure technically efficient. Among the nine overall efficient firms, four were privately held Indian firms, three were privately held foreign firms, and two were group-owned Indian firms. In terms of scale efficiency, only nine firms in the entire sample were scale efficient.

Data Source and Variables
In this study, data was sourced from the Centre for Monitoring Indian Economy (CMIE) Prowess database. Considering that DEA results can be influenced by sample size, we followed two guidelines: a) The number of decision-making units (DMUs) should exceed the number of variables used for inputs and outputs, and b) The number of DMUs should be at least three times the total number of inputs and outputs (Mahajan, Nauriyal & Singh, 2014a). Furthermore, DEA requires continuous data availability. The Prowess database lists 883 pharmaceutical companies for the period 2004-2023. However, only 40 of these firms had complete data for all input and output variables throughout the entire period. This sample size adheres to the aforementioned guidelines. We use DEA to analyze the export efficiency of the Indian Pharmaceutical Industry (IPI), employing the following variables in our analysis.

Output Variable:

a) Export Sales

Input Variables:

a) R&D Expenses
b) Import of Raw Materials Expenses
c) Compensation Paid to Employees
d) Marketing Expenses (Advertising + Distribution + Promotional Expenses

Table 1: List of 37 sample firms

Company Name		Company Name	
1	Aarti Drugs Ltd.	20	Mangalam Drugs & Organics Ltd.
2	Ahlcon Parenterals (India) Ltd.	21	Medicamen Biotech Ltd.
3	Alchem International Pvt. Ltd.	22	Mercury Laboratories Ltd.
4	Auro Laboratories Ltd.	23	Micro Labs Ltd.
5	Bal Pharma Ltd.	24	Morepen Laboratories Ltd.
6	Concept Pharmaceuticals Ltd.	25	N G L Fine-Chem Ltd.
7	Divi's Laboratories Ltd.	26	Nectar Lifesciences Ltd.
8	East India Pharmaceutical Works Ltd.	27	Orchid Pharma Ltd.
9	Flamingo Pharmaceuticals Ltd.	28	Panacea Biotec Ltd.
10	Fredun Pharmaceuticals Ltd.	29	Raptakos Brett & Co. Ltd.
11	Fresenius Kabi Oncology Ltd.	30	Serum Institute of India Pvt. Ltd.
12	Gennex Laboratories Ltd.	31	Shilpa Medicare Ltd.
13	Icpa Health Products Ltd.	32	Shodhana Laboratories Pvt. Ltd.
14	Ind-Swift Ltd.	33	Somerset Therapeutics Ltd.
15	Ishita Drugs & Inds. Ltd.	34	Sri Krishna Pharmaceuticals Ltd.
16	Jagdale Industries Pvt. Ltd.	35	Unidrug Innovative Pharma Technologies
17	Kopran Ltd.	36	Vasudha Pharma Chem Ltd.
18	Lee Pharma Ltd.	37	Wanbury Ltd.
19	Macleods Pharmaceuticals Ltd.		

ANALYSIS AND DISCUSSION
Table 2 gives a summary of the total and mean values of all the output and input variables for 37 firms included in the sample during 2004-2013 and 2014-2023. It can be noted that the mean values have increased during 2014-2023 over 2004-2013.

Table 2: Total and Mean Values of Output and Input Variables

	2004-2013		2014-2023	
	Total	Mean	Total	Mean
Export Sales	61521.3	1662.7	253630.3	6854.9
R&D Expenses	2598.9	70.2	6817.9	184.3
Import of Raw Materials	21266.0	574.8	93378.0	2523.7
Marketing Expenses	7190.0	194.3	15880.7	429.2
Compensation	13027.0	352.1	47164.1	1274.7

Table 3: No. of Efficient Firms during 2004-2013 and 2014-2023			
	2004-2013	2014-2023	20 Years
CRSTE	3	4	2
VRSTE	11	12	7

It can be observed from Table 3 that the number of efficient firms during the 20-year period (2004-2013 & 2014-2023) were only 2 and 7 using CRSTE and VRSTE respectively. Table 4 presents the mean CRSTE and mean VRSTE scores during 2004-2013 and 2014-2023. It is noted that the mean CRSTE and VRSTE scores have only marginally increased or remained largely constant over the 10-year period during 2004-2013. Surprisingly. The mean CRSTE and VRSTE scores decreased during 2014-2023. It was expected that the export efficiency of the Indian pharmaceutical industry would continue to improve in the post-TRIPS period after 2004-2005 but was found to decrease over the 20-year period.

Table 4: Mean CRSTE and VRSTE Scores										
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Mean CRSTE	0.53	0.56	0.61	0.59	0.56	0.59	0.58	0.51	0.55	0.60
Mean VRSTE	0.76	0.77	0.78	0.79	0.75	0.77	0.76	0.70	0.75	0.76
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Mean CRSTE	0.61	0.62	0.62	0.48	0.47	0.49	0.53	0.44	0.42	0.42
Mean VRSTE	0.76	0.79	0.77	0.70	0.68	0.69	0.74	0.71	0.69	0.69

Table 5: Scale Efficiency of Sample Firms (2004-2013 & 2014-2023)										
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Scale Efficiency (CRSTE/VRSTE)	0.70	0.74	0.79	0.75	0.75	0.76	0.76	0.73	0.73	0.80
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Scale Efficiency (CRSTE/VRSTE)	0.81	0.78	0.79	0.68	0.69	0.72	0.72	0.62	0.61	0.61

It can be observed from Table 5 that the scale efficiency of the Indian pharmaceutical industry has increased from 0.70 to 0.80 during 2004-2013 but has decreased from 0.81 to 0.61 during 2014-2023. This was contrary to the expected results. This could partially be attributed to the structural changes in the Indian economy (demonetization and implementation of GST) coupled with the impact of Covid-19 pandemic. The results of this study are congruent with the research reported by Rentala, Anand and Shaban (2017) who investigated the export efficiency of the Indian pharmaceutical industry during transitory-TRIPs (1995-2004) and post-TRIPS (2005-2014) periods. In their study, the authors found that the export efficiency improved during 2005-2014 which is in line with the findings of this research. This research extended the study beyond 2014 till 2023 to examine the trend in the export efficiency only to find that the export efficiency decreased during 2014-2023.

CONCLUSIONS

After India joined the WTO on January 1, 1995, the Indian pharmaceutical industry has seen a significant increase in exports. However, export growth was slightly slower during the transition period (1995-2004) compared to the post-TRIPS era (2004 onwards). This slower growth can be attributed to the uncertainty faced by the industry immediately after India signed the WTO agreement. Despite these initial concerns, the industry has progressively followed a growth path, largely due to leveraging global market opportunities.

The industry's success has been driven by its ability to provide high-quality products at competitive prices. In this study, we assessed the efficiency of Indian pharmaceutical exports from 2004 to 2023, aiming to determine whether the industry improved its export efficiency while actively pursuing global export opportunities.

We anticipated that our findings would show a steady increase in export efficiency for the Indian pharmaceutical industry since India's WTO membership. We also hypothesized that the industry's efficiency will continue to improve in the post-TRIPS period (2004-2023). Our results indicate that the export efficiency of the Indian pharmaceutical industry decreased during 2014-2023. Future research could use this methodology to analyze export efficiency across other Indian industries like automobiles, electronics and software in the context of institutional reforms from 1991 (the start of economic reforms) or from 1995 (India's WTO accession), potentially leading to more detailed investigations into the export efficiency of various sectors in emerging economies like India.

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