From Generics To Innovation: India's Pharma Battles For Global Trade Supremacy

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DECLARATION BY STUDENT

I hereby declare that the data presented in this Dissertation report entitled, “From Generics To Innovation: India’s Pharma Battles For Global Trade Supremacy” is based on the results of investigations carried out by me in the M.A Economics, at the Goa Business School, Goa University under the supervision of Prof. B.P. Sarath Chandran and the same has not been submitted elsewhere for the award of a degree or diploma by me. Further, I understand that Goa University or its authorities will be not be responsible for the correctness of observations / experimental or other findings given the dissertation.

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Prof. B.P. Sarath Chandran

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PREFACE

I am Leander Savio Fernandes, 22 years old, a student at the Goa Business School of Goa University, getting a degree in Masters of Economics. I have always been fascinated by international trade and I could credit the choice of me picking economics to international trade too. While doing my first year at Goa University, we had a small project where we had to calculate the Revealed Comparative Advantage of HS2 classification goods of India's trade. While working on the project I couldn't help but wonder, 'Why does a product with the HS Classification 30, come in and out of the top 5 goods with RCA?' the fluctuations and movements were something that I thought was interesting enough to set on to do research on and that's how I picked the Indian Pharmaceutical Industry. In this research paper, I have studied the Pharma Industry from the ground up piecing together pieces that contribute to the growth or explanation of the growth of the Indian Pharmaceutical Industry. I believe and from the understanding gathered from the present literature and also from the analysis of this research, Research, and Development are the main driver of the industry, investment in it would lead to higher exports, a better chances of filing for patents and a stock of well guaranteed pharmaceutical products. Analyzing the impacts of investing in R&D that spill over other features and studying the effects of policies on those R&D investments while potentially explaining Mergers and Acquisitions for this purpose is what is covered in this paper, a well constructed regression models and statistical analysis help uncover the secret ingredients involving in the growth of the Pharmaceutical industry which fuels India's economic growth and job creation, solidifying its role as a major player in the global pharmaceutical landscape. The Pharmaceutical industry is one that has great potential, one that has seen a lot of fluctuations and still stood up straight, by exploring this topic, I hope to contribute valuable insights that can support the continued growth and innovation of this vital industry.

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I would be remiss without expressing my sincere gratitude to those who supported me throughout this research journey. Professor B.P. Sarath Chandran deserves special thanks for his invaluable guidance and encouragement. His expertise in the field was instrumental in shaping this research, his ability to entertain me during challenging moments and patiently correct my errors, kept me motivated and focused. I am also grateful to the entire faculty of the M.A Economics Discipline of the Goa Business School of Goa University for creating a stimulating academic environment and giving me the know-how and the knowledge to carry out this research. Finally, I extend my deepest appreciation to my parents for their unwavering support and encouragement. This research would not have been possible without their belief in me. To all those going through this paper, I want to thank you for showing interest in my work and supporting me.

ABSTRACT

This study examines the transformation of the Indian Pharmaceutical Industry (IPI) since liberalization in 1992 and includes the pre and post-era of the TRIPS agreement as well as the pre and post-era of COVID-19 up to 2023. Following the introduction of product patents and the TRIPS agreement, the industry has shifted from generic production to innovation through increased R&D investment. Market competition has intensified with new entrants over the years, leading companies choose to prioritize R&D over marketing strategies. The research finds a positive causal relationship between R&D expenditures and export performance, suggesting that investments in R&D directly impact export growth. Furthermore, the IPI has achieved a trade surplus in pharmaceuticals, exporting significantly more than it imports. A small section dedicated to Mergers and Acquisitions lays the path to understanding why those events take place and the benefits that come off it. The research concludes that continued stakeholder support can propel the IPI towards becoming a global leader in Pharma Exports with R&D and innovation, potentially contributing to India's economic prosperity.

Keywords: Indian Pharmaceutical Industry, R&D, NRCA, Market Concentration, Pairwise Granger Causality test, VAR Model.

Abbreviations: IPI (Indian Pharmaceutical Industry), NRCA (Normalised Revealed Comparative Advantage), CR (Concentration Ratios), R&D (Research and Development) M&A (Mergers and Acquisitions), TRIPS (Trade Related Integrated Property Rights)

CONTENTS

TABLES

FIGURES

CHAPTER 1: INTRODUCTION

Our body's natural defense system, the immune system, can be likened to a well-fortified castle under siege. White blood cells act as diligent soldiers, constantly patrolling and repelling invaders like viruses and bacteria. However, some enemies may be overwhelming in number or possess superior weaponry. In such situations, pharmaceuticals can play a crucial role. Antibiotics function like reinforcements for the immune system's army, bolstering its ability to combat infections. Vaccines, on the other hand, act as specialized weaponry, training the body to recognize and effectively neutralize specific threats. Additionally, medications like antihistamines can be seen as repairs for the castle walls, alleviating weaknesses that might otherwise leave the body vulnerable to allergic reactions. By supporting the body's inherent defenses in these ways, pharmaceuticals become a vital ally in maintaining health and overcoming illness. This analogy is just one of the many that shed light on why the pharmaceutical industry plays such a crucial role in human and animal life, for some it’s a source of healing, for some it acts like a form of maintenance, for many, it is a source of recovery, but there are some whose life depends on it. Pharmaceuticals are relied upon so much that they help some people breathe, the industry worldwide has seen massive growth over the years, a very profitable industry but one that comes with a lot of rules and regulations when it comes to packaging, ingredients, transport, storage, and so on.

For decades, India's pharmaceutical industry has thrived in the shadows, quietly churning out affordable generics to a thirsty world. Today, fueled by ambition and innovation, this global giant stands poised to rewrite the rules of trade dominance. While India's reputation rests on its prowess in generics, a quiet revolution is brewing within its labs. Driven by an insatiable hunger for innovation, pharmaceutical giants are venturing beyond copycats, seeking to carve their own niche in the realm of groundbreaking drugs. Today India’s Pharmaceutical

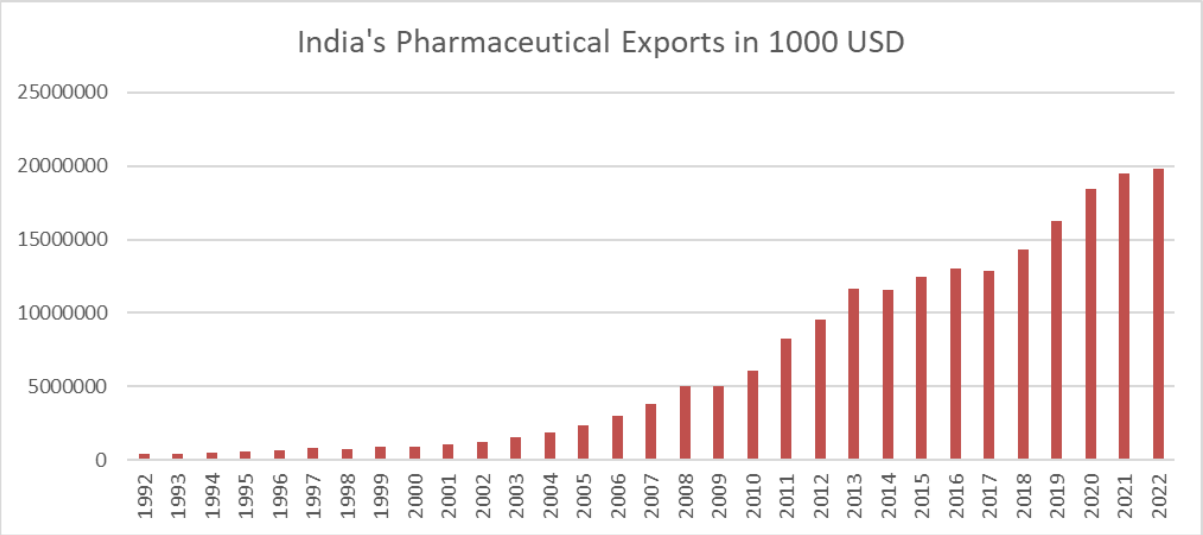
Industry is known as the “Global pharmacy of the world”. India offers almost every product that has gone off-patent and with a large vendor base. (Suri & Banerji, 2016). India's shift towards self-sufficiency in life sciences by the 1990s was driven by the emergence of high-quality domestic players, replacing the pre-1970s era of import reliance. Since then, world-class capabilities have helped the Indian industry build a strong global presence.(Suri & Banerji, 2016) As a 50-billion-dollar valued industry, the Indian Pharmaceutical Industry is a major exporter, serving over 200+ countries with their exports. India supplies over 50% of Africa’s requirement for generics, ~40% of generic demand in the US, and ~25% of all medicine in the UK. (*Formulating Success: The Indian Pharmaceutical Industry*, n.d.) India’s drug usage during 2022 is put at a total of 443 billion doses in total accounting for 14% of Global consumption, which works out to 0.86 doses per capita daily. (*Pharmexcil_Annual_Report_2022-23.Pdf*, n.d.) As an industry that might as well be the ‘Oil’ to the Arab countries the Pharma companies have huge potential to seek growth and with growth, they will see an increase in exports which will lead not only to financial benefits but also positive externalities that I believe will be the key to solve major problems across the country. Moving from branded generics to patented products will see an increase in foreign direct investment and mergers and acquisitions taking place. Since the dawn of the 60’s the government has paid attention to the pharmaceuticals industry but off late with the figures sought from exports and financial benefits and the steady growth, the government of India has introduced various benefits including schemes and tax benefits. The Prime Minister, Shri Narendra Modi inaugurated the first Global Innovation Summit of the Pharmaceuticals sector. The Prime Minister said that the pandemic has brought the pharmaceutical sector into sharp focus. Whether it is lifestyle, medicines, medical technology, or vaccines, every aspect of healthcare has received global attention over the last two years (*PressReleasePage.Aspx*, n.d.). In this context, the Prime Minister said that the Indian pharmaceutical industry has also risen

to the challenge. (*PM Inaugurates the First Global Innovation Summit of the Pharmaceuticals Sector*, n.d.)

1.1 INDIAN PHARMACEUTICAL EXPORT

The scenario of the IPI has seen a massive change since the 1970's. From 1970-1990, India was engaged in pharma production of branded generics and off-brand generics for domestic consumption and domestic needs, 1990-2010 saw massive growth and liberalization allowed Indian products to be introduced in foreign markets, meanwhile, the Indian pharmaceutical industry was also part of a Global Value Chain that was engaged in packaging pharma products sent from China and then distributing them. Post 2010, India is now a major competitor, manufacturing every brand and off-brand product in the market while engaging in R&D and competing for patents. The script of the IPI has altered over a period of time; Indian firms have grown more technically sophisticated, skilled in reverse engineering, and developing new processes for pharmaceutical production. In March 2005, India completed the amendment of the Patent Act of 1970 to comply with the TRIPS Agreement. It introduced product patents for drugs, food, and chemical products, and the patent term was increased to 20 years. This change in patent ended the free-run of the Indian firms to replicate the newly developed and marketed pharmaceutical products of other firms (Mahajan, 2019).

Figure 1.1. Indian Pharmaceutical Exports 1992-2022 in 1000 USD



Source: World Integrated Trade Solutions (WITS)

The Indian pharmaceutical industry grew at a CAGR of 14.02819746% over the period 1992 to 2022. Impressive growth in pharmaceutical exports can be attributed to patent expiries of several branded products marketed by MNCs in developed markets like the US and Europe (Suri & Banerji, 2016). The United States is the dominant importer of Indian pharmaceuticals, as depicted in the table below, accounting for nearly 30% of total exports at $7.5 billion. Several European nations like Belgium, Netherlands, France, and Germany follow closely, highlighting a strong European demand for Indian pharmaceuticals. This trend likely reflects factors like affordability and the wide range of generic drugs offered by India. Beyond established markets, countries like South Africa, Brazil, and Russia are emerging as promising destinations, possibly due to their developing healthcare systems and growing need for medication. Interestingly, the United Kingdom shows a decline in imports compared to the previous year, suggesting potential reasons like currency fluctuations or changes in procurement policies. Overall, the data indicates the US and Europe as key destinations, with promising growth prospects in other regions.

Table 1.1 The Top 10 Destinations of India's Pharmaceutical Exports (Value in USD Million)

Rank	Country	FY 22-23 Exports	Growth	Contribution
1.	UNITED STATES OF AMERICA	7547.54	6.18	29.72
2.	BELGIUM	714.92	59.20	2.82
3.	SOUTH AFRICA	657.00	7.23	2.59
4.	United Kingdom	647.68	-8.26	2.55
5.	BRAZIL	642.67	10.09	2.53
6.	NETHERLANDS	594.31	29.04	2.34
7.	RUSSIA	573.20	-4.19	2.26
8.	FRANCE	569.80	10.92	2.24
9.	GERMANY	523.03	-1.18	2.06
10.	NIGERIA	515.96	-12.30	2.03

Source: (*Pharmexcil_Annual_Report_2022-23.Pdf*, n.d.)

Today India's Pharmaceutical Industry is known "Global pharmacy of the world". India offers almost every product that has gone off-patent and with a large vendor base. India's filings of (Drug Master File) DMF's with (United States Food and Drug Administration) USFDA as of Dec 2013 is 3411, the highest filed by any country globally. India after achieving considerable success as the first to file an Abbreviated New Drug Application (ANDAs) with USFDA, has now made a beginning of the segment of super generics. India has already two Market authorizations under this category from the USFDA, which further supplements India's pharmaceutical chemistry skills(Suri & Banerji, 2016)

1.2 R&D ACTIVITY OF THE INDIAN PHARMACEUTICAL INDUSTRY

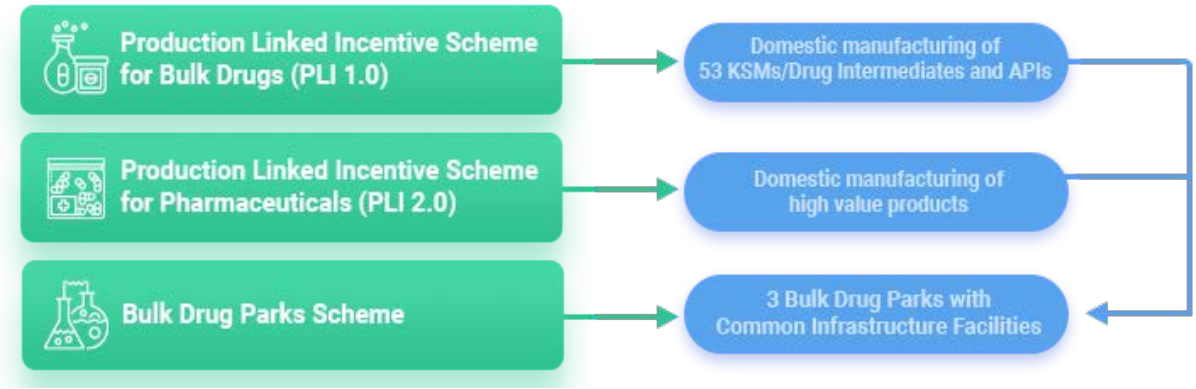
After India joined the TRIPS agreement in 1995, domestic companies substantially boosted their spending on research and development (R&D). However, while Indian pharmaceutical R&D investment has grown under TRIPS, it remains considerably lower when compared to the investments made by multinational corporations (MNCs) on a global scale. The R&D spending of Indian Pharmaceutical companies further accelerated post-2005 upon the preface of the Product Patent Regime. Due to large investments, companies have erected strong product channels for the US market, but negligible development has taken place on the New Chemical Entity (NCE) front. India's stricter patent laws have spurred a shift in focus for domestic pharmaceutical companies. They're now heavily targeting the generics market in developed countries, making India a major exporter of finished drugs. However, there's a growing reliance on imported active ingredients, the raw materials for these drugs. Meanwhile, multinational drug companies in India are buying fewer local ingredients and finished medications. They're increasingly choosing to invest in financial assets instead. The industry is consolidating through mergers and acquisitions, which increases market dominance and helps companies capture opportunities across the entire drug production chain, both domestically and internationally. Notably, no Indian company has the capability to develop a drug from scratch and bring it to market alone. They typically partner with multinational corporations for research and development, which can lead to a focus on treatments for non-critical diseases like those related to lifestyle. The development of India's pharmaceutical sector offers valuable context for understanding various issues. First, the Indian policy environment toward both technology and FDI underwent considerable changes during the sample period. Broadly, policies were liberal in the 1960s, made very stringent in the 1970s, attempts at liberalization were made in the 1980s, and then real liberalization took place in the early 1990s. At the same time, the policy environment was characterized by discretionary control and a lack

of transparency(Feinberg & Majumdar, 2001). There has been an exceptional rise in R&D expenditure, especially after the signing of TRIPs in 1995, although a rising trend is visible even before that. It picked up incentives by 2000 and attained a peak in 2006 after which it stabilized. It may be pointed out that prior to 1992, new drug discovery and development had never been on the agenda of the Indian pharmaceutical firms, as reflected in their output and from the fact that there was an almost marginal investment in R&D with some larger firms such as Ranbaxy, DRL, Lupin, Cipla, IPCA, etc., investing, on an average, around 2 percent of their sales revenue on R&D as compared to 15-20 percent in regard to the Western firms (Mahajan, 2019).

1.3 POLICY

To ensure greater resilience to external shocks, enforce greater drug security, and boost the capacity for domestic production for critical bulk drugs and high-value products alike, the Department of Pharmaceuticals has launched 3 supporting schemes to incentivize the global and domestic players to enhance investment and production in these product categories(Sharma, 2023). The Schemes are envisioned to ensure greater resilience of the Indian pharmaceutical industry to external shocks and contribute significantly to achieving a higher objective of affordable healthcare in the country and globally on a sustained basis (*Government Scheme for Pharmaceuticals Manufacturing | Invest I...*, n.d.).

Figure 1.2. Graphical Representation of the 3 Major Pharmaceutical Schemes



Source: (*Government Scheme for Pharmaceuticals Manufacturing | Invest I...*, n.d.)

1.3.1 Production Linked Incentive Scheme for Bulk Drugs (PLI 1.0) As Notified on 21 July 2020

The Production Linked Incentive (PLI) Scheme for the promotion of domestic manufacturing of critical Key Starting Materials (KSMs)/Drug Intermediates (DIs) and Active Pharmaceutical Ingredients (APIs) in India(Singh & Joseph, 2023). Production Linked Incentives of up to INR 6,940 crores have been approved. A financial incentive will be given to eligible manufacturers of identified 41 eligible products which covers 53 APIs, for 6 years, committed investment, and sales made by selected applicants for the eligible products. The rates will vary for Fermentation-based products and Chemically Synthesized products(*Production Linked Incentive Scheme For Pharmaceuticals (Ver. 2.0)*, 2021).

1.3.2 Production Linked Incentive Scheme for Pharmaceuticals (PLI 2.0) As Notified on 03 March 2021

The objective of the scheme is to enhance India's manufacturing capabilities by increasing investment and production in the sector and contributing to product diversification of high-value goods in the pharmaceutical sector. One of the further objectives of the scheme is to create global champions out of India who have the potential to grow in size and scale using cutting-edge technology and thereby penetrate the global value chains (*Production Linked*

Incentive Scheme For Pharmaceuticals (Ver. 2.0), 2021). The manufacturers of pharmaceutical goods registered in India will be grouped based on their Global Manufacturing Revenue (GMR) to ensure wider applicability of the scheme across the pharmaceutical industry and at the same time meet the objectives of the scheme(*Production Linked Incentive (PLI) Scheme for the Pharmaceutical Sector*, n.d.). The qualifying criteria for the three groups of applicants will be as follows:

a. *Group A:* Applicants having Global Manufacturing Revenue (FY 2019-20) of pharmaceutical goods more than or equal to INR 5,000 cr.

b. *Group B:* Applicants having Global Manufacturing Revenue (FY 2019-20) of pharmaceutical goods between INR 500 (inclusive) cr and INR 5,000 cr.

c. *Group C:* Applicants having Global Manufacturing Revenue (FY 2019-20) of pharmaceutical goods less than INR 500 cr. Within this group, a sub-group for the MSME industry will be made given their specific challenges and circumstances(*Cabinet Approves Production Linked Incentive Scheme for Pharmaceuticals*, n.d.).

1.3.3 Scheme for Bulk Drug Parks as Notified on 21 July 2020

The scheme on Promotion of Bulk Drug Parks for financing Common structure installations in 3 Bulk Drug Parks with monetary recrimination of INR 3,000 crore for 2020-2021. backing under the scheme will be permissible for similar installations by the State Government in Bulk Drug Parks. Parks will have common facilities such as solvent recovery plants, distillation plants, power and steam units, common effluent treatment plants, etc. (*Government Scheme for Pharmaceuticals Manufacturing | Invest I...*, n.d.) (*Options for Indian Pharmaceutical Industry in the Changing Environment*, 2023)

As India completes 75 years of Independence, the country's pharmaceutical industry can look back with pride on its journey thus far. After independence, for more than 2 decades, India relied heavily on imports. The sector has grown exponentially to produce close to 85%

of the domestic needs. Over the last two decades particularly, the pharmaceutical industry has grown from strength to strength, turning into a major exporter of generic medicines and vaccines(Jain & Jatkar, 2022). As one of the top five sectors contributing to foreign exchange earnings and employing over 2.7 million people, it plays a major role in the Indian economy.

1.4 NORMALIZED REVEALED COMPARATIVE ADVANTAGE

The normalized revealed comparative advantage (NRCA) index measures the degree of derivation of a country's actual export from its comparative advantage-neutral level in terms of its relative scale with respect to the world export market and thus provides a proper indication of the underlying comparative advantage (Mahajan, 2019).

Understanding India's Competitive Advantage, the NRCA (Normalized Revealed Comparative Advantage) measure takes into account the size of the country and its overall export patterns, going beyond the basic RCA. This gives a more precise view of India's competitive edge in the global pharmaceutical market. A high NRCA value for pharmaceuticals indicates that India not only exports more because of its size but also has a genuine advantage in producing these products compared to other countries. Identifying Areas for Enhancement, analyzing the trends in NRCA over time can show whether India's advantage is getting stronger or weaker. If the NRCA is decreasing, it may indicate the need to invest in research and development, enhance infrastructure, or tackle specific challenges faced by the industry.

When policymakers consider India's NRCA, they can use this information to create policies that help the pharmaceutical industry. They can focus on fostering innovation, attracting foreign investment, and negotiating beneficial trade agreements. To understand how India compares to other pharmaceutical exporters, policymakers and industry leaders can analyze the NRCA. This analysis can highlight areas where India performs well and where competitors may have an edge. By pinpointing strengths and weaknesses, they can develop strategies to enhance India's position in the global market.

1.4.1 Helping Investors Make Informed Decisions

A strong NRCA can indicate a lucrative market for investors looking at the Indian pharmaceutical sector. This may lead to increased investment in research and development, production plants, or particular drug categories that offer a significant competitive edge.

Since we live in a country that is constantly developing and which has great potential in pharmaceutical exports which at present time have become a necessity, it is very important to study the industry further, while our exports are growing and the valuation is at a whopping $50 Bn, India doesn't even appear in the top 5 while comparing via the NRCA (Normalized Revealed Comparative Advantage). Similarly, while we have seen competent growth and contribution to the drug and pharmaceutical industry, the picture painted by previous research stated that there was a lot done for the industry but that wasn't enough to compete with the giants in the industry. The scenario post-COVID has seen significant change in the area of what the government is doing, as mentioned above, the Prime Minister along with other people in power has seen the importance and the scope that the Indian Pharmaceutical Industry poses. There has been a major change with the introduction of Nationwide schemes, websites, laws laid down, and plenty of promotional drives that positively impact the industry. Standing at a crossroads in the global pharma arena, India faces both headwinds and tailwinds on its journey to trade supremacy through innovation. This research peels back the layers of this pivotal moment, illuminating a roadmap for policymakers and industry stakeholders to navigate the path ahead, armed with insights gleaned from a multifaceted analysis of policy reforms and industry dynamics.

1.5 AIM

To explore avenues for fostering innovation and increasing India’s share in the Global Pharmaceutical market.

1.6 OBJECTIVES

The objectives of the present study are as follows

1. To understand the trade competitiveness of pharmaceutical industries in India

2. To analyze the Indian pharmaceutical industry's transformation following the Product Patent Act along with the examination of how the market structure, ownership patterns, trade performance, research and development spending, and mergers and acquisitions have all evolved.

3. To study the causal link between R&D expenditure, exports, and the size of the pharmaceutical Industry.

1.7 RESEARCH QUESTIONS

1.7.1 How Has the Indian Pharmaceutical Industry Transformed?

a. *Market Structure:* To what extent has the introduction of product patents in 1995 led to consolidation within the Indian pharmaceutical industry? How has this affected competition and the diversity of offerings?
b. *Ownership Patterns:* Has there been a shift in ownership patterns from domestic to foreign companies since 1995? How has this impacted R&D investment and product focus?
c. *Trade Performance:* How has the trade balance of the Indian pharmaceutical industry changed since 1995? What are the main drivers of growth in exports and imports?
d. *R&D Expenditure:* How has the level and allocation of R&D expenditure within the Indian pharmaceutical industry evolved since 1995? What are the factors influencing these trends?

e. *Mergers and Acquisitions:* What are the motivations behind mergers and acquisitions in the Indian pharmaceutical industry? How have these transactions impacted the industry's competitive landscape?

1.7.2 Is Pharmaceutical Trade India's Greatest Strength?

a. India's NRCA compared to the top 10 major producers of pharmaceutical products.
b. Compare and contrast India's NRCA with other countries to realize the title ‘Pharmacy of the developing world.’
c. India’s Export-Import ratio
d. Firm-level data on profits after tax, total Income, and financial value of total exports

1.7.3 What Causal Relationships Exist Within the Indian Pharmaceutical Industry?

a. *Granger Causality Tests:* Does R&D expenditure Granger cause increased exports within the Indian pharmaceutical industry? If so, what is the underlying mechanism driving this relationship?
b. *Vector Autoregression (VAR) Models:* What is the dynamic relationship between factors like R&D expenditure, exports, and the size of the pharmaceutical industry? How do these variables interact with each other over time?

1.7.4 How Can We Inform Policy Decisions Regarding the Indian Pharmaceutical Industry?

a. *Policy Effectiveness:* Which existing policies have been most effective in supporting the growth and innovation of the Indian pharmaceutical industry? How can these policies be further optimized?
b. *New Policy Proposals:* Based on the research findings, what new policy measures could be implemented to address identified challenges and leverage opportunities for the Indian pharmaceutical industry?

1.7.5 How Can We Empower Stakeholders in the Indian Pharmaceutical Industry?

a. *Competitive Landscape Analysis:* What are the key trends shaping the global pharmaceutical market that industry stakeholders need to be aware of? How can Indian companies adapt their strategies to remain competitive?
b. *Risk and Opportunity Assessment:* Based on the research findings, what are the key risks and opportunities facing the Indian pharmaceutical industry? How can companies best mitigate risks and capitalize on opportunities?

1.8 HYPOTHESES

1.8.1 Hypothesis 1 (Concentration and Competition)

1. Null Hypothesis (H_0): There will be no significant change in the market concentration of the Indian pharmaceutical industry over time.

1.8.2 Hypothesis 2 (Internationalization and Growth)

1. Null Hypothesis (H_0): There is no causal relationship between R&D (Capital + Current) expenditure and export performance.

1.8.3 Hypothesis 3 (Foreign Share and Competitiveness)

1. Null Hypothesis (H_0): The share of the Indian market held by foreign companies will not decrease over time.
2. Null Hypothesis (H_0): India's exports of pharmaceutical products will not see an increase over time in the global scenario.

1.8.4 Hypothesis 4 (Specialization and Advantage)

1. Null Hypothesis (H_0): The specialization of pharmaceutical products have no comparative advantage as compared to products of other industries.
2. Null Hypothesis (H_0): The comparative advantage of pharmaceutical products has seen no improvement over time.

1.8.5 Hypothesis 5 (Acquisitions and Strategy)

1. Null Hypothesis (H_0): There is no significant difference in the motivations for recent acquisitions in the Indian pharmaceutical industry compared to motivations driven solely by financial considerations or short-term gains.

1.9 RESEARCH GAP

There is a vast literature that covers the pharmaceutical industry, from the most noticeable years to every corner of the industry, asking the question ‘What will this paper do that others haven't yet?’ is a good one to ask. This paper attempts to paint a big picture by combining those corners and building our own walls to not only cover or study a small area of the industry but rather work from the ground- up while paying attention to what's in between to study or rather analyze the whole industry. The research questions mentioned above shed some light on what's inside and hopefully by the end of the research paper, the assembled puzzle will look like a masterpiece.

The vast literature present out there barely covers the industry or the scene post-COVID, past literature predicted growth in the Research and Development expenditure due to many expiring patents, and the figures on R&D Capital and Current expenditure have been analyzed using the Vector Autoregression Models. This research has taken a different route to mainstream analysis and uses multiple tests and methods to study the industry.

All in all this research seeks to uncover the IPI domestically by studying the concentration of companies in India, looking at India's Exports and specialization, Mergers and Acquisitions, and some firm-level data. This research analyses the industry between the time frame 1992-2023 looking at 936 different pharmaceutical companies in India, their profits after tax, total exports, and total income. Using the Pharmaceutical Exports + IPI Sales + R&D Current Expenditure + R&D Capital Expenditure as variables to run the VAR model and

Granger Causality Test, we seek to uncover any underlying cause-and-effect relationship that will hopefully guide future decision-making.

CHAPTER 2: LITERATURE REVIEW

2.1 OVERVIEW

This chapter encompasses the literature that supported the research, while it is an original research it is structured using a combination of other literatures that help enhance the body and the idea behind the study. A literature review is an essential first step for any research project. It acts as a roadmap, guiding one through the existing knowledge on the topic. By thoroughly reviewing past research, one gains a solid foundation, avoiding unnecessary repetition and ensuring their work builds upon what's already been established. This process also helps identify gaps in current research, pinpointing areas where this project can make a unique contribution to the field. Ultimately, a well-constructed literature review strengthens the credibility of the research by demonstrating your familiarity with the subject and positioning your work within the broader scholarly conversation. This chapter is broken down into sub-chapters that make up the variables/ tests that shape this research,

1. The Pharmaceutical Market
2. Normalized Revealed Comparative Advantage
3. Research and Development
4. Sales
5. Mergers and Acquisitions

There is a vast amount of literature on the Pharmaceutical Industry, some might say it is getting congested there but that works as a perfect guide to finding a new way or using a particular study done for another country, to be studied for India. A vast amount of literature enables one to join forces and combine ideas to get a rather more concrete study and eliminate gaps or loopholes. This research aims to do exactly that by combining different studies and

different subgroups to paint a bigger picture of the Indian Pharmaceutical industry. This section highlights the key areas that this research has dealt with by highlighting major variables.

2.2 THE INDIAN PHARMACEUTICAL INDUSTRY

A study conducted by (Suri & Banerji, 2016) titled “A study of disaggregated R&D expenditure on Indian pharmaceutical exports” talks about how the Indian pharmaceutical industry has made significant progress over the past few decades, transitioning from import dependence to self-sufficiency by the 1990s and establishing a strong global presence. The industry is export-intensive, with the top companies generating more than sixty percent of their sales from exports, particularly to the US and Europe. R&D spending by Indian pharmaceutical firms has been consistently increasing, with approximately six percent of sales being allocated to R&D. (Mahajan, 2019) in his study stated that the industry, historically operating under a process patent regime that facilitated the growth of a strong generics market, has transitioned into a product patent regime since 2005, necessitating a shift towards more innovation-driven competition.

The study “Structural changes and trade competitiveness in the Indian pharmaceutical industry in product patent regime” also goes a mile ahead to understand the impact of this transition on market structure, ownership patterns, trade performance, R&D expenditure, and mergers and acquisitions (M&As), considering the industry's market concentration through concentration ratios and the Herfindahl-Hirschman Index (HHI). The research paper explores the structural changes and global competitiveness of the Indian Pharmaceutical Industry (IPI) in the context of the product patent regime implemented as part of India’s commitment to the TRIPS agreement. “Trade performance and revealed comparative advantage of Indian pharmaceutical industry in new IPR regime” (Mahajan et al., 2015) a study done before the one above by Mahajan 2015 preached that the Indian pharmaceutical industry, a dynamic sector of the Indian economy, has exhibited remarkable growth, especially in exports, over the past

few decades. Initially reliant on imports and dominated by multinational corporations until the early 1970s, the industry underwent significant transformation following the implementation of the Indian Patent Act, which facilitated process patenting. This legislative change enabled Indian firms to reverse-engineer existing drug products, thereby eroding the market dominance of foreign firms and establishing India as a major producer of pharmaceutical products. Studies indicate that India's industry excelled in exporting generics, leveraging its comparative advantage in the production of lower-cost medicines, thereby gaining a significant share in global markets, particularly in developing countries. Compliance with international standards, such as those set by the Food and Drug Administration (FDA), further facilitated the growth in exports. By volume, India is ranked third worldwide in pharmaceutical production and exports a substantial proportion of the world's generics, meeting a considerable portion of global demand for such products. (*Patents_and_the_Indian_Pharmaceutical_Industry.Pdf*, n.d.) a paper by Nilesh Zacharias and Sandeep Farias examines the evolution, challenges, and implications of patent laws in the Indian pharmaceutical industry, focusing on the consequences of liberalizing the economy for this sector.

(Dosi et al., 2023) in their paper “Do Patents Really Foster Innovation in the Pharmaceutical Sector? Results from an evolutionary, agent-based model” employs an evolutionary, agent-based model to study the impact of patents on innovation, technological diffusion, and industry dynamics in the pharmaceutical sector. The paper delves into the contemporary dysfunctionality of the patent system and the potential policy debates on reforming the system. It addresses the role of patents in promoting innovation, technological feasibility for private firms, and the worldwide availability of vaccines during health crises. Patents have a complex effect on innovation, with a minimum degree of protection being beneficial, but negative effects emerge as the breadth or length of patents increases, potentially hindering innovation, increasing prices, and market concentration. The Indian pharmaceutical

industry, comprised mainly of domestic companies, has thrived due to government support and limited international competition. However, economic liberalization is pushing the industry toward global markets, necessitating a reconsideration of long-term strategies, especially regarding intellectual property (IP) protection.

(Jha, 2007) “Options for Indian Pharmaceutical Industry in the Changing Environment” by Ravinder Jha provides a comprehensive overview of the Indian pharmaceutical industry's response to the changing global and domestic patent environment, particularly after India's alignment with the TRIPS agreement. With a shift towards stricter patent laws, including the recognition of product patents since 2005, Indian pharmaceutical companies, historically focused on the production of generic drugs due to India's earlier process patent regime, are navigating a new landscape that includes greater import dependence on active pharmaceutical ingredients, a trend towards consolidation via mergers and acquisitions, and strategic partnerships with multinational corporations (MNCs) for R&D in the pursuit of tapping into the lucrative generics market of developed countries. The paper outlines that for over three decades, the Indian pharmaceutical sector thrived under a regime that recognized only process patents, which bolstered the domestic industry and allowed it to supply affordable medicine domestically and to developing countries. This was facilitated by the Indian Patents Act (IPA) 1970, among other regulatory measures. However, the last amendment in 2005, which finally recognized product patents, marked a significant shift, compelling Indian firms to redirect their strategies toward the generics market in developed countries while facing increased import dependence for raw materials. The research delves into the strategies adopted by the top 15 Indian pharmaceutical companies to remain competitive in this new environment. These strategies include increased focus on exports, investment patterns shifting towards financial securities over manufacturing, and leveraging mergers and acquisitions for consolidation and expansion. The study provides detailed data on production, imports, and exports, revealing a

complex picture of reliance on imports for active pharmaceutical ingredients against a backdrop of declining shares in the market for MNCs and shifting investment preferences.

2.3 THE PHARMACEUTICAL MARKET

The pharmaceutical market is a global ecosystem driven by research, development, manufacturing, and distribution of medications aimed at treating and preventing diseases. Valued at over $1.5 trillion, it is a complex and ever-evolving space where innovation and accessibility intertwine with significant challenges.

At the heart of this market lies the relentless pursuit of new drugs. Pharmaceutical companies invest heavily in research and development (R&D), striving to discover and develop novel therapies for a vast array of medical conditions. From life-saving cancer treatments to medications for chronic illnesses like diabetes, the success of R&D translates into improved patient outcomes and a healthier global population.

However, the path from discovery to market is arduous and expensive. Clinical trials, a crucial stage in ensuring drug safety and efficacy, can be lengthy and resource-intensive. Stringent regulatory processes further add to the complexity, ensuring only rigorously tested medications reach patients. This focus on safety, while essential, can create a bottleneck, delaying access to potentially life-saving treatments.

Accessibility is another cornerstone of the pharmaceutical market. The ability of patients to afford and obtain the medications they need is paramount. Here, the landscape becomes intricate. While generic drugs, lower-cost versions of brand-name medications, play a vital role in increasing affordability, intellectual property (IP) laws can create barriers. Patents granted to pharmaceutical companies grant them exclusive rights to produce and sell their drugs for a set period, often leading to higher prices. This tension between innovation and affordability necessitates a delicate balancing act – fostering R&D while ensuring medicines remain accessible to those who need them most.

Beyond affordability, geographic disparities in access pose a significant challenge. Developed nations often have first access to new drugs, while those in developing regions may face delays or struggle to afford essential medications. Here, international organizations and initiatives play a crucial role in bridging the gap. Programs like the World Health Organization's Essential Medicines List aim to ensure access to life-saving drugs in resource-limited settings.

The rise of personalized medicine is another emerging trend shaping the pharmaceutical market. This approach tailors treatments to patients based on their genetic make-up and specific medical conditions. While personalized medicine holds immense promise for improved treatment outcomes, ethical considerations surrounding data privacy and potential cost implications need to be addressed.

Looking ahead, the future of the pharmaceutical market is likely to be shaped by several key factors. Technological advancements in areas like genomics and artificial intelligence have the potential to revolutionize drug discovery and development, leading to faster and more targeted therapies. Additionally, the growing burden of chronic diseases worldwide will continue to drive demand for innovative treatments.

However, navigating these advancements alongside the challenges of affordability, accessibility, and ethical considerations will be critical. Striking a balance between fostering innovation, ensuring access to essential medicines, and upholding ethical principles will be paramount in ensuring the pharmaceutical market serves the greater good of global health.

A section of “A study of disaggregated R&D expenditure on Indian pharmaceutical exports” by (Suri & Banerji, 2016) studied how the pharmaceutical industry in India is highly segmented, with intense price competition and government price control. Branded generics currently dominate the market, constituting about 90% of pharmaceutical sales, and this dominance is expected to continue until 2020. However, there is projected growth in patented

drug sales by 2020 due to improved patent laws and increased health insurance coverage. The industry has experienced robust growth in pharmaceutical exports, particularly to the US, and is expected to continue benefiting from patent expiries in developed markets. A paper titled “Economics of the Pharmaceutical Industry” (Lakdawalla, 2018) discusses the economics of the pharmaceutical industry, focusing on the positive and normative implications for the innovation, pricing, and marketing decisions of pharmaceutical firms. The paper highlights the substantial chunk of the US economy's research and development investments made by the pharmaceutical industry, resulting in significant medical breakthroughs such as the treatment of high cholesterol, heart disease, and HIV. It touches on the rising costs of pharmaceutical products and the pressure to adopt direct or indirect controls on pharmaceutical prices. The paper also explores the behavior of pharmaceutical firms, including the pricing for new medicines, reimbursement of drugs, and the influence of drug advertising on physicians and patients.

“Technology, regulation, and market structure in the modern pharmaceutical industry” (Temin, 1979) discussed the transformation of the American pharmaceutical industry in the 1950s, focusing on the regulatory and technological conditions that influenced changes in drug marketing and industry structure. It shows the change between the pre-World War II and post-war drug industries, offering an explanation for the emergence of the pharmaceutical industry's modern shape and describes the evolution of competition among patented drugs. The regulatory climate changed with the passage of the 1938 Federal Food, Drug, and Cosmetic Act, which decisively altered the way drugs were marketed. The technological basis of the drug industry changed as the "wonder drugs" were discovered just after the war. The impact of discoveries in the drug industry was affected by the way the new technologies were applied to drugs and by the regulation of drugs under the 1938 Act. Meanwhile (Mahajan, 2019) in “Structural changes and trade competitiveness in the Indian pharmaceutical industry in product patent

regime” while referring specifically to India found the IPI to be highly fragmented yet demonstrating oligopolistic tendencies with the top firms holding substantial market shares. The TRIPS regime ushered in a phase of increased market consolidation, driving up M&As as firms sought economies of scale and resource integration to bolster their stance.

The paper "The Market Impacts of Pharmaceutical Product Patents in Developing Countries: Evidence from India" (Duggan et al., 2016) by Duggan, Garthwaite, and Goyal assesses the effects of India's patent reform on pharmaceutical prices, sales, and market structure following the adoption of the Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement. The research exploits variations in the timing of patent decisions to estimate the impact of product patents on average price, quantity sold, and market structure. A paper examined the impact of pharmaceutical companies' profits on public health, focusing on the pricing and marketing strategies employed. The author acknowledged the need for pharmaceutical companies to make a reasonable profit from developing drugs that contribute to public health. However, concerns are raised regarding the actual profit margins and pricing strategies adopted by these companies, said (Deangelis, 2016) in “Big Pharma Profits and the Public Loses”. (Lakdawalla, 2018) Additionally addresses the political economy of intellectual property protection and the complexities of pharmaceutical market power. It discusses the implications of buyer size, market power, and competitive dynamics within the pharmaceutical market, shedding light on the efficient and inefficient aspects of drug pricing and reimbursement.

Considering the competition in the market, “High-growth firms in changing competitive environments: the US pharmaceutical industry (1963 to 2002)” (Mazzucato & Parris, 2015), The paper disclosed a shift in the competitive environment of the US pharmaceutical industry from 1963-2002 and its impact on the R&D-growth, emphasizing the implications for innovation policy. The examination of the changing competitive environment

in the pharmaceutical industry from 1963 to 2002 revealed the need for careful consideration of the competitive environment in an industry. The study suggested that industrial policy, particularly high-growth firm policy, must be linked to competition policy and should be linked to the competitive conditions in which firms operate. The findings demonstrated that attention to high-growth firms must be accompanied by a careful consideration of the competitive environment in an industry, regardless of its cause.

Peter Temin in a paper they wrote in 1979 reveals that the technical and regulatory changes led to a dramatic increase in vertical integration and an accompanying rise in the size of drug firms (Temin, 1979). However, despite these changes, there was not an increase in profitability relative to other industries nor an increase in concentration. The data on drug firms showed that the size of drug firms increased dramatically at the same time as drug firms reallocated their expenditures toward research and development and marketing. Despite the apparent success of the new drugs in generating profits for pharmaceutical firms, the paper reveals that the apparent failure of industry profits to rise relative to average manufacturing profits suggests that the technological and regulatory revolution may not have increased market power in the pharmaceutical industry. The findings of (Duggan et al., 2016) reveal that the research paper provides valuable insight into the consequences of implementing a product patent system in India, shedding light on the effects of patent reform on pharmaceutical prices, quantities sold, and market structure. Overall, the study demonstrates how the introduction of product patents under TRIPS in India had modest effects on prices, with larger increases for more recently developed molecules, suggesting that the reform did not significantly impact quantities sold or the number of pharmaceutical firms operating in the market. The study suggests that the patent reform resulted in an average price increase of 3-6 percent for molecules receiving a patent(Jha, 2007). The analysis revealed a trend: newer molecules and those initially controlled by a single firm saw steeper price increases upon patent

implementation. However, the impact on quantities sold and the number of pharmaceutical firms in India was little to none. The findings indicate that the implementation of the pharmaceutical patent reform did not lead to a significant change in the number of firms producing molecules. It was also highlighted that there was an increase in sales concentration at the molecule level, suggesting the pricing shift towards the originating firms. Additionally, the paper suggests that the patent reform did not result in a noticeable increase in the number of new molecule introductions in the Indian market. In “The Market Impacts of Pharmaceutical Product Patents in Developing Countries: Evidence from India” (Duggan et al., 2016), they indicate that the patent reform had a relatively limited impact on the pharmaceutical market in India, with little change in average quantity and prices, suggesting a modest influence on access to pharmaceuticals and consumer welfare in India. The paper also suggests that the lack of substantial price effects may limit the increase in expected profits for pharmaceutical firms, affecting incentives for innovation in the market.

2.4 NORMALIZED REVEALED COMPARATIVE ADVANTAGE

Studies have stated that Export/Import Ratios and the value of exports are the only prerequisites but the Normalized Revealed Comparative (NRCA). The NRCA is a metric used in international trade to assess a country's comparative advantage in exporting a specific good relative to its trading partners. It's an improvement on the traditional Revealed Comparative Advantage (RCA) index. In “Structural changes and trade competitiveness in the Indian pharmaceutical industry in product patent regime” (Mahajan, 2019) showed that trade performance analysis revealed a significant growth in exports, positioning India as a key player in the global pharmaceutical market, especially in generics. Nonetheless, the industry’s heavy reliance on bulk drug imports from China exposes a critical vulnerability. The enactment of the Product Patent Act has augured well for foreign direct investment, fostering a more competitive and technically sophisticated IPI.

However, the Normalized Revealed Comparative Advantage (NRCA) index, a measure of trade competitiveness, indicates fluctuating comparative advantages for India in the global pharmaceutical trade landscape. Using the Revealed Comparative Advantage Index (RCAI) and Trade Specialization Coefficient (TSC) (Mahajan et al., 2015) in “Trade Performance and Revealed Comparative Advantage of Indian Pharmaceutical Industry in New IPR Regime” provides insights into India's Competitive Position Relative to other leading exporters. Although India has crafted a niche in the generic drugs market and excels in exports, data suggests that countries like Ireland and Israel have outperformed India in terms of moving up the value chain and integrating into global production networks more effectively. A paper titled “Comparative Advantage in UK Manufacturing Trade, 1910-1935” (Crafts & Thomas, 1986), their research paper aimed to investigate the sources of comparative advantage in UK manufacturing trade before World War II by applying a modified Heckscher-Ohlin model to trade in manufactures. The study found that the UK had a comparative disadvantage in goods used massively in the use of human capital, while the US had the reverse pattern of comparative advantage. The UK was found to have a stable comparative advantage in unskilled labor-intensive and capital-neutral commodities. The findings suggested that the UK's industrial leadership in the 19th century was due to a favorable endowment of natural resources and sufficient labor, but its scarcity of human capital hindered its performance in technologically progressive industries in the late 19th and early 20th centuries. The paper also highlighted the UK's relatively low levels of labor productivity in manufacturing compared to other countries, indicating structural weaknesses in the economy. The results indicated that the UK had an ongoing lack of trading prowess in high-wage goods, which were associated with underinvestment in human capital and a relative lack of success in technologically advanced industries. The study concluded that the structure of the British economy was more difficult to transform than suggested by superficial analyses, and it continued to face challenges and

weaknesses in the inter-war period. Overall, the research provided insights into the historical patterns of comparative advantage in the UK manufacturing trade and shed light on the underlying structural weaknesses of the British economy during that period.

The research paper "Globalization & Indian Jute Industry: Competitiveness & Performance" (*Globalization & Indian Jute Industry: Competitiveness & Performance*, 2011) explores the impact of globalization on the Indian jute industry's competitiveness and performance. Even though it is a different industry the concept of NRCA is highlighted well when the paper further assessed the Normalized Revealed Comparative Advantage (NRCA) index to measure the competitive position of jute products in the world market. It identified trends in the export and import shares of developing and developed regions, indicating a shift of jute market concentration towards developing regions. The study suggests that the imperfect market structure of the domestic and external markets, along with slow adaptation to changing market conditions, has led to market stagnancy for the Indian jute industry(*Globalization & Indian Jute Industry: Competitiveness & Performance*, 2011). The research paper "India-China Trade: Lessons Learned and Projections for 2015" by Jean-Joseph Boillot and Mathieu Labbouz discusses the trade relationship between India and China since the early 1990s and potential future trends. The paper describes the dynamic opening of trade between the two countries, highlighting the trends that might emerge by 2015 and their implications for the future configuration of world trade. We examine two possibilities:(1) an ongoing expansion of trade between the two Asian economies, and (2) the rise of a united "India and China" as a major world power. The latter scenario appears more probable, considering the models of specialization and industrial transformation followed by the two countries at both the micro and macroeconomic levels, (Boillot & Labbouz, 2006).

The paper “The Export-Diversifying Impact of Japanese and US Foreign Direct Investments in the Indian Manufacturing Sector” (Banga, 2006) Analyzes the effects of US

and Japanese foreign direct investment on the diversification of exports in India's manufacturing industry, The study emphasizes that FDI may lead to export diversification in a developing country by positively affecting the export intensity of industries with a lower share in world exports. Additionally, FDI may encourage export diversification through spillover effects, positively influencing the export intensity of domestic firms. The empirical results from the Indian economy show that FDI from the US has led to the diversification of India's exports, both directly and indirectly, while Japanese FDI has had no significant impact on India's exports.

(Boillot & Labbouz, 2006) provides an assessment for 2015, shows that China is still largely ahead of India in terms of trade, with services not covered in the study and a somewhat insignificant India-China bilateral flow at the world level. The authors evaluate the economic "mass" differences, the temporal gap in opening up trade, and the more gradual and structurally different opening up in Southern Asia, emphasizing the asymmetrical but dynamic nature of the Indian economy. The paper explores the impact of China's entry into the World Trade Organization (WTO) on India's trade and discusses the potential consequences of India's trade deficit with China. The authors also analyze the specializations and industrial transformations of India and China, indicating that India is focusing on a specialized range for developed countries with an upgrade in the added value of products, and China is moving towards mass production with greater technological content. The paper underlines the increasing interweaving of India and China and the potential positive outcomes of their cooperation for world trade configuration. Overall, the paper provides an insightful analysis of the trade relationship between India and China and offers valuable insights into the potential future trends in world trade configuration.

The (Banga, 2006) findings highlight the significance of the source-country dimension of FDI and the heterogeneity of FDI in influencing export diversification in the Indian

manufacturing sector. The paper sheds light on the role of FDI in export promotion and emphasizes the importance of considering the mode of foreign market entry and transaction costs through the external market in analyzing FDI's impact on exports in developing countries. Conclusively (Mahajan et al., 2015), the Indian pharmaceutical industry's journey from import dependence to becoming a significant player in the global market exhibits both its achievements and challenges. Adapting to a stricter intellectual property regime post-TRIPS, the sector has managed to maintain a strong export presence, especially in generics. However, to sustain growth and enhance competitiveness, the industry needs to address challenges like legal disputes, dependence on foreign sources for key raw materials, and the imperative to innovate continually.

2.5 RESEARCH AND DEVELOPMENT

Research and Development (R&D) is the lifeblood of the pharmaceutical industry. It's the engine that drives innovation and brings new life-saving drugs, therapies, and vaccines to market. Here's why R&D is so crucial:

1. Improved Health Outcomes

New drugs can treat previously untreatable diseases, manage chronic conditions more effectively, and improve the overall quality of life for patients.

2. Combating Emerging Threats

R&D is essential for developing defenses against new infectious diseases and antibiotic-resistant bacteria.

3. Economic Benefits

A thriving pharmaceutical industry creates high-paying jobs in scientific research, manufacturing, and healthcare.

The model given in the study by Giovanni Dosi, Elisa Palagi, Andrea Roventini, and Emanuele Russo validates various industry regularities such as increasing industry size, R&D

spending, product variety, emerging oligopolistic core, and right-skewed distributions of firm size and growth rates. The policy experiments suggest that stronger patents negatively impact innovation rates and new drug discoveries while raising prices and market concentration. These results indicate that an excessive extent and duration of patents may not be beneficial for innovation and industry dynamics, (Dosi et al., 2023).

The study (Mahajan, 2019) “Structural Changes and Trade Competitiveness in the Indian Pharmaceutical Industry in Product Patent Regime” notes a substantial increase in R&D expenditure post-2005, suggesting a strategic shift toward innovation and development to compete globally. However, this increase in R&D spending is concentrated among larger firms, indicating a disparity in the innovation focus within the industry. The paper also identifies the rising concentration ratios post-2005, illustrating the growth in market power of the larger firms, potentially at the expense of smaller players. (Dosi et al., 2023) examines the role of patents in the context of R&D incentives by exogenously varying the R&D share in response to changes in patent breadth or length. This approach allows testing whether there is a positive relation between the intensity of search efforts and R&D incentives and how it may vary with the level of patent protection. The findings suggest that patents may have both positive and negative effects on innovation, highlighting the need for a careful balance in the extent and duration of patent protection to support innovation and industry dynamics in the pharmaceutical sector.

(Suri & Banerji, 2016) reveals that there is a strong causal relationship between pharmaceutical exports and R&D capital expenditure, indicating that an increase in R&D capital expenditure leads to a significant increase in pharmaceutical exports. However, the impact on exports is short-lived, lasting only about one year. R&D current expenditure marginally affects pharmaceutical exports. The findings suggest that pharmaceutical exports drive R&D capital expenditure, and a consistent investment in R&D is essential for maintaining

and expanding international market presence. The study recommends that the Indian pharmaceutical industry shift its focus toward investing in developing new products, such as New Chemical Entities, to sustain long-term growth in global markets. It also suggests that the government should negotiate agreements with the US government to facilitate Indian drug manufacturers' participation in procurement contracts and provide support for R&D funding. Additionally, the industry should explore innovative partnership models and enhance collaborations between academia, public institutions, and industry to strengthen R&D activities and talent development. (Mahajan et al., 2015) spoke about liberalization policies under the World Trade Organization's (WTO) Trade-Related Intellectual Property Rights (TRIPS) agreements further shaped the industry's trajectory. Indian pharmaceutical firms, which had capitalized on the production of generic drugs due to lower production costs and minimal R&D expenditures, faced challenges as TRIPS mandated adherence to stricter intellectual property rights standards. Consequently, to remain competitive in the global market and comply with international norms, Indian companies initiated their own research and development programs while also engaging in contract manufacturing and research in “Trade performance and revealed the comparative advantage of the Indian pharmaceutical industry in new IPR regime.” (Mahajan et al., 2015)

(Jha, 2007) discusses the implications of the changing patent landscape on R&D within the Indian pharmaceutical industry. Given the enormous costs and expertise required to develop drugs from investigational stages to market launch, Indian firms typically collaborate with MNCs. This scenario often results in a focus on lifestyle-related diseases prevalent in the developed world, to the detriment of research into diseases that disproportionately affect the developing world. The analysis also highlights the industry's response to the generics market opportunity presented by the expiry of patents on blockbuster drugs in key markets. A study titled “High-growth Firms in Changing Competitive Environments: the US Pharmaceutical

Industry (1963 to 2002)" investigates the relationship between R&D investments and economic growth in the US pharmaceutical industry from 1963 to 2002, with a focus on the conditions under which high-growth firms matter for this translation. The authors use quantile regression to study the R&D-growth relationship in high-growth firms compared to low-growth firms and analyze how this relationship depends on the industry's life cycle. The study examines the changing competitive environment in the pharmaceutical industry over the specified period and its impact on the R&D-growth relationship, emphasizing the implications for innovation policy (Mazzucato & Parris, 2015). In the study "Pharmaceutical High Profits: The Value of R&D, or Oligopolistic Rents?" by Janet Spitz and Mark Wickham, the authors explore the claims made by pharmaceutical firms regarding high prices and high profits in relation to their research and development (R&D) costs. The study tests the validity of these claims using data from annual reports (Spitz & Wickham, 2012). The study focuses on examining the claims made by pharmaceutical firms regarding high prices and high profits in relation to their research and development (R&D) costs. The researchers used data from annual reports of pharmaceutical firms to investigate the relationship between R&D expenses and profits. They examined a sample of pharmaceutical companies and found that the average profit margin for firms reporting R&D was significantly higher than for those that did not report R&D. This finding suggests that pharmaceutical companies may be generating higher profits as a result of their R&D investments.

The research paper titled "Does Public Scientific Research Complement Private Investment in Research and Development in the Pharmaceutical Industry?" (Toole, 2007) analyzes the relationship between publicly supported biomedical research and pharmaceutical research and development (R&D) investment. It uses new micro-level data on investment provided by the U.S. National Institutes of Health to examine the impact of public basic and clinical research on pharmaceutical R&D investment and differences in the relevance and

degree of scientific and market uncertainty between these two types of research. “Drug Prices and Research and Development Investment Behavior in the Pharmaceutical” (Giaccotto et al., 2005) investigates the relationship between real drug prices and pharmaceutical research and development (R&D) spending, as well as the potential impact of drug price controls. The paper argues theoretically and demonstrates empirically that pharmaceutical R&D spending increases with real drug prices. Specifically, the estimated elasticity suggests that a 10 percent increase in the growth of real drug prices is associated with a nearly 6 percent increase in the growth of R&D intensity. The paper also explores the determinants of pharmaceutical R&D, particularly how various public policies, such as drug price regulations, might affect pharmaceutical R&D(Giaccotto et al., 2005). It considers the impact of policies such as the Health Care Reform Act of 1993, which proposed various types of price controls on the pharmaceutical industry.

(W Light & Lexchin, 2012) “PHARMACEUTICAL R&D What do we get for all that money” explores the pharmaceutical industry's research and development (R&D) spending and the outcomes of this investment. The authors challenge the perceived "innovation crisis" in the pharmaceutical sector, arguing that the real crisis stems from current incentives that provides positive incentives to companies for developing numerous new drugs with minimal clinical benefits compared to existing ones. The paper discusses the declining productivity of R&D expenditures and the push for new drug discovery despite limited therapeutic advances, emphasizing the need for a more critical examination of the industry's innovation claims. The paper highlights the escalating costs associated with pharmaceutical R&D, attributing the high prices to the industry's focus on developing minor variations of existing drugs rather than genuinely innovative solutions. The authors argue that the current business model incentivizes the production of marginal drugs that provide little therapeutic value, posing a significant challenge to the pharmaceutical research landscape.

The paper “Pharmaceutical Research And Development And The Patent System” (Love, 2005) The paper delves into the pharmaceutical industry's research and development (R&D) expenditures and the impact of the patent-based system on incentivizing marketing practices masquerading as research, leading to a corrupting influence on the R&D process. While the pharmaceutical industry exaggerates its R&D expenditures, it spends billions annually, heavily influenced by the patent-based system, which rewards innovators with a marketing monopoly. This system creates rewards for marketing more than for research, which inevitably corrupts the R&D process. The paper also highlights the non-financial factors influencing innovation, such as cognitive breakthroughs driven by academic or government researchers. It discusses the importance of shared information in the development process, such as open medicine models, which seek to give researchers access to research tools and data to enable collaborative research projects. The primary barriers to the development of new drugs are cognitive, despite the significant private sector investment in R&D. Additionally, the paper presents an analysis of R&D costs for self-originated drugs tested in humans between 1970 and 1982, estimating the average R&D cost of discovering and developing a new drug for the US market and discussing the time costs and the attrition rate of drug compounds. The study observes that R&D costs have increased rapidly in real terms, particularly at the pre-clinical level, with the increasing emphasis on chronic diseases contributing to higher costs. The study also forecasts the potential industry-wide savings in R&D costs with a reduction in regulatory approval times.

The paper (Ramachandran, 2023) emphasizes the heavy visible and invisible costs borne by the nation for foreign capital and technology in the pharmaceutical industry. It calls for a thorough study of the industry's technology, modifications of processes, and efforts towards substitution of imported raw materials to attain the national objective of self-sufficiency in drugs. The lack of major innovation in the near future, as reflected in the present

trends in Research and Development (R&D) investments, is noted. “Economics of the Pharmaceutical Industry” paper delves into the institutional and regulatory features of the pharmaceutical industry, emphasizing its research and development (R&D)-intensive nature and the tension between patent protection and market exclusivity created by regulatory fiat. It describes the pharmaceutical product's "life cycle," outlining the decision-making problems faced by pharmaceutical firms and their customers. The article discusses the economic interplay of the unique features of the pharmaceutical industry and the implications for public policy, considering total employment and planned R&D costs in selected industries. (Lakdawalla, 2018) Furthermore, the paper delves into the relationship between cash flow, profitability, and research and development (R&D) spending in the pharmaceutical industry. It provides insights into the determinants of innovation productivity, citing multiple scientific and regulatory considerations that influence the probability of a new drug discovery successfully treating diseases. The paper also discusses the impact of regulatory factors, such as the FDA process and its approval timelines, on the probability of bringing a new drug to the market.

Overall, the study (Suri & Banerji, 2016) provides valuable insights into the relationships among R&D expenditure, pharmaceutical exports, and total sales in the Indian pharmaceutical industry, and it offers important recommendations for policymakers and industry stakeholders to further enhance the industry's internationalization and sustainable growth.

Mazzucato & Parris, in a study conducted in 2015 demonstrate that the R&D-growth relationship is sensitive to the changing competitive environment over the industry's history, suggesting that innovation policy must focus on competitive structures in addition to firm attributes(Mazzucato & Parris, 2015). The paper provides detailed analyses of R&D investments, firm-specific factors, industry life cycle, competitive environment, and innovation

policy implications. Furthermore, the paper presents comprehensive descriptive analyses of the pharmaceutical industry, including the composition of SMEs, merger and acquisition activities, industry concentration, market share instability, and R&D intensity. The findings reveal that the competitive environment significantly influences the relationship between R&D investments and economic growth, particularly for high-growth firms. The study provides valuable insights into the nuanced relationship between R&D, growth, and industry dynamics, offering essential implications for innovation policy and firm-level strategies. The findings revealed a positive R&D-growth relationship post-1980, particularly for high-growth firms (HGF). R&D intensity was identified as a positive determinant of growth, especially for firms with growth observations at the median quantile or above. It was observed that firms investing in R&D performed well when the competitive environment was strong. The findings from (Spitz & Wickham, 2012) reveal that pharmaceutical firms indeed invest in R&D, but they also enjoy strong rents. Over two decades (from 1988 to 2009), pharmaceutical companies made significantly higher profits compared to the average across all industries. These profits were anywhere from 3 to 37 times greater, even though pharmaceutical companies invested proportionally less of their earnings into research and development (R&D) compared to other companies that rely heavily on R&D. The authors also highlight the substantial rise in healthcare costs, including the cost of pharmaceutical products, and the significant contribution of pharmaceutical spending to total healthcare costs in the United States. The study's analysis reveals that pharmaceutical companies enjoy substantially higher profits compared to non-pharmaceutical companies, even though they invest heavily in research and development., garners negative returns. The findings suggest that regulatory intervention. While industry-designed solutions can be helpful, for the best public outcomes, these plans need careful consideration alongside fiscal responsibility and investment in groundbreaking treatments. The study also discusses the potential for regulations to increase transparency in pharmaceutical

firms' expenditures in marketing and gifts and to address the transfer of taxpayer-funded research into pharmaceutical patents.

Toole, in a study conducted in 2007 finds evidence that public basic and clinical research are complementary to pharmaceutical R&D investment, stimulating private-industry investment. The analysis specifically shows that public basic research has a U-shaped impact on pharmaceutical investment, with a quick response followed by a period of holding investment constant before another increase, reflecting the influence of scientific and market uncertainties(Toole, 2007) . On the other hand, public clinical research, which has less scientific and market uncertainty, leads to a shorter and smaller investment response from pharmaceutical firms, with a significant impact within the first 3 years. The study also emphasizes the importance of considering the nature and degree of uncertainty of public research in determining the timing and magnitude of private-industry investment. The paper provides detailed insights into the complementarity between publicly supported biomedical research and pharmaceutical R&D investment, laying the groundwork for further research on the impact of public funding on private investment in the pharmaceutical industry. Giaccotto studies simulations based on the multiple-regression model indicate that if the federal government had limited the rate of growth in drug price increases to the rate of growth in the general consumer price index during the period 1980–2001, the capitalized value of pharmaceutical R&D spending would have been about 30 percent lower. Furthermore, the results suggest that a drug price control regime would have resulted in 330 to 365 fewer new drugs being brought to the global market during that same time period (Giaccotto et al., 2005). Using industry-level data from 1952 to 2001, the paper presents a theoretical model and empirical evidence for the relationship between drug prices and R&D spending. The study demonstrates the significance of pharmaceutical R&D spending and the potential trade-off between greater access to pharmaceuticals today and innovation tomorrow. In conclusion, the

paper provides insights into the effects of drug price controls on pharmaceutical R&D spending and the potential implications for new drug launches. It emphasizes the importance of considering the economic trade-offs associated with pharmaceutical price controls and the impact on future pharmaceutical innovation. The paper provides a detailed analysis of the relationship between drug prices and pharmaceutical R&D spending, drawing on theoretical models, empirical evidence, and policy implications to illustrate the potential impact of drug price controls on pharmaceutical innovation. The article also sheds light on the hidden business model of pharmaceutical research, sales, and profits, which relies on promoting numerous minor variations of drugs to generate steady profits, even at the expense of substantial therapeutic advancements. The authors criticize the excessive spending on developing drugs with minimal benefits, pointing to the need for a shift towards more cost-effective and safer medicines. They advocate for stricter market authorization regulations, such as requiring evidence of comparative efficacy at the time of licensing, to address the proliferation of marginally effective drugs flooding the market. In conclusion, the paper urges for a fundamental change in the pharmaceutical industry's business model to prioritize the development of truly innovative and therapeutically significant drugs. It emphasizes the need to reconsider the current R&D incentives and regulatory frameworks to ensure that pharmaceutical investments yield substantial clinical benefits for patients. The authors also advocate for increased public funding for basic research to drive genuine therapeutic breakthroughs and reduce the industry's reliance on minor drug variations. (Love, 2005) their paper extensively discusses the impact of the patent-based system on the pharmaceutical industry's R&D expenditures, the neglect of diseases with minimal buying power for drugs, the distorted healthcare research, and the corrupting influence of marketing on the R&D process. It provides a critical analysis of the industry's practices and their implications for public health and innovation. The research paper “The Costs And Returns To Pharmaceutical Research And

Development” presents an empirical analysis of the innovative performance and structure of the pharmaceutical industry, focusing on the costs and returns to pharmaceutical research and development (R&D). The study begins by discussing R&D costs and returns on an industry-wide basis for new chemical entities (NCEs) introduced in the United States in the 1980s. It compares the returns in the 1980s with the 1970s, revealing a significant increase in real R&D costs over the period. The analysis suggests that the optimal size of R&D budgets has increased, leading to a number of major mergers in the industry. The study also discusses the implications of the findings on the optimal size of R&D budgets and the occurrence of major mergers in the industry. It highlights the consistently high returns on equity in the US pharmaceutical industry and attributes the industry's success to successful innovation and increasing costs per prescription for established drugs during the 1980s. It also touches upon the wave of mergers and strategic alliances in the industry, driven by the high threshold costs of R&D and the distribution of sales emerging from pharmaceutical innovation processes (GRABOWSKI & VERNON, 1992). (Spitz & Wickham, 2012) found that In terms of implications for healthcare policy in the United States, the study's findings suggest that there may be a need to address the relationship between R&D costs, pharmaceutical profits, and drug pricing. The evidence of higher profits for firms reporting R&D highlights the potential impact of R&D investments on pharmaceutical companies' financial performance. This could inform discussions surrounding the regulation of drug pricing and the extent to which R&D expenses should factor into pricing considerations. Additionally, the findings underscore the importance of understanding the dynamics between R&D investments and profitability within the pharmaceutical industry when formulating healthcare policies that aim to balance innovation, access, and affordability of pharmaceutical products. Love in 2005 says the patent-based system does not incentivize research into diseases that affect the poor in developing countries, leading to neglect of diseases with minimal buying power for drugs. Additionally, the system distorts healthcare research in

rich country markets, leading to large sums of money being invested in me-too drugs with minimal clinical benefits over existing therapies(Love, 2005).

2.6 SALES

The paper “High-growth Firms in Changing Competitive Environments: the US Pharmaceutical Industry (1963 to 2002)” (Mazzucato & Parris, 2015) discusses the significance of 'high-growth firms' (HGF) for innovation policy and emphasizes the skewed ability of firms to engage with innovation and translate investments in innovation into higher growth. It highlights that the effect of R&D on firm growth is not homogeneous across firms and discusses the importance of understanding what types of firms are most critical for generating innovation and economic growth in knowledge-based economies. The paper explored the relationship between high-growth firms and the translation of R&D investments into economic growth. It discussed the conditions under which high-growth firms matter for this translation, taking into account firm-specific and industry-specific factors. A key aspect of this research was analyzing the R&D-growth relationship for high-growth and low-growth firms using quantile regression. The study also examined how this relationship depends on the industry's life cycle. The research paper “Economics of the Pharmaceutical Industry” provides a comprehensive analysis of the economics of the pharmaceutical industry, focusing on the various factors that affect investment, pricing, and public policy. The paper explores the implications of different financing structures on investment decisions by pharmaceutical firms, particularly focusing on the impact of internally generated capital versus external capital on investment behavior. It suggests that the availability of internal funds influences investment and affects the marginal return demanded on capital investment. (Lakdawalla, 2018). (Deangelis, 2016) their paper “Big Pharma Profits and the Public Loses” presents alarming statistics on pharmaceutical companies' profit margins, which range from 10% to 42%, and emphasizes that these profit margins are comparable to those of banks. The paper raises

concerns about the high drug prices in the United States and highlights the lack of price negotiation measures in the country's healthcare system, unlike in other developed countries. The paper discusses the influence of pharmaceutical lobbyists on US Congress, preventing Medicare from negotiating drug prices.

Mark Duggan along with his colleagues in 2016 finds that the introduction of a patent system in India had a modest average price increase of approximately 3% for molecules that received a patent, and larger increases for more recently developed molecules and single-firm molecules when the patent system began. These changes in prices were not statistically significant for molecules first sold prior to 1995. The results indicate that the reform did not exert a significant impact on the quantities sold or the number of pharmaceutical firms operating in the market(Duggan et al., 2016). The research paper explores the impact of India's pharmaceutical patent reform implemented in 2005 in compliance with the 1995 Trade-Related Aspects of Intellectual Property Rights (TRIPS). The paper investigates the average price increase for molecules, the variation in price increases for different types of molecules and firms, its effect on quantities sold, and the number of pharmaceutical firms in India. The findings (Mazzucato & Parris, 2015) revealed a positive R&D-growth relationship post-1980, particularly for high-growth firms (HGF). R&D intensity was found to be a positive determinant of growth, especially for firms with growth observations at the median quantile or above. It was observed that firms investing in R&D performed well when the competitive environment was strong. The study demonstrated the need for research to be sensitive to industry dynamics, underscoring the implication that a changing competitive environment profoundly impacts the R&D-growth relationship. Furthermore, the research highlighted the implications for innovation policy.

2.7 MERGERS AND ACQUISITIONS

Mergers and Acquisitions (M&A) represent a significant force shaping the corporate world. These transactions involve the consolidation of companies or their assets, fundamentally altering the competitive landscape. Understanding the motivations behind M&A activity, the situations that trigger them, and the potential benefits they offer is crucial for navigating the ever-evolving business environment.

At its core, an M&A deal can be categorized as either a merger or an acquisition. In a merger, two roughly equal-sized companies combine forces to create a new, single entity. This often occurs when both companies benefit from economies of scale, a larger customer base, or a more diversified product portfolio. A classic example is the 1998 merger of Daimler-Benz and Chrysler, which formed DaimlerChrysler, a powerhouse in the automotive industry.

On the other hand, an acquisition involves a larger company taking over a smaller one. The acquiring company absorbs the target's assets, technology, or market share. This strategy can be particularly enticing for companies seeking to expand quickly or enter new markets. For instance, Facebook's acquisition of Instagram in 2012 bolstered its social media dominance by capturing the growing photo-sharing market.

Several factors can trigger the need for M&A activity. A company might seek a merger to achieve economies of scale. By combining operations and resources with another company, they can reduce costs associated with production, distribution, and administration. This approach has the potential to enhance the organization's financial performance and solidify its competitive advantage.

Another common driver is the pursuit of market share and growth. Through an acquisition, a company can instantly gain access to a new customer base or distribution network. This can be especially advantageous in saturated markets where organic growth is

slow. Mergers can also be a way to expand product offerings and diversify revenue streams, making the combined entity less susceptible to market fluctuations.

M&A activity can also be fueled by the desire to acquire strategic assets or intellectual property. A company might target another with cutting-edge technology, a skilled workforce, or a strong brand reputation. Owning these assets allows the acquiring company to innovate faster, improve product quality, or gain a marketing advantage.

Furthermore, M&A can be a strategy to eliminate competition. By acquiring a direct competitor, a company can reduce competition in the market, potentially leading to higher prices and increased profitability. This tactic, however, often faces scrutiny from regulatory bodies to ensure fair market practices.

The potential benefits of a successful M&A are numerous. Companies can leverage economies of scale, reduce operational costs, and streamline processes. Acquisitions can offer immediate access to new markets, customers, and talent, accelerating growth. Additionally, M&A can unlock valuable synergies, where the combined entity is more than the sum of its parts, leading to greater innovation and profitability.

However, M&A deals are complex undertakings fraught with risks. Integration challenges can arise due to differing corporate cultures, incompatible technologies, and employee resistance. Additionally, overpaying for a target company or underestimating integration costs can significantly impact shareholder value.

In conclusion, M&A activity is a cornerstone of the modern business landscape. Companies engage in mergers and acquisitions for various reasons, including achieving economies of scale, expanding market share, acquiring strategic assets, or eliminating competition. While successful M&A can unlock significant benefits, careful planning, thorough due diligence, and a focus on integration are crucial for maximizing the potential of these transactions. By understanding the motivations, triggers, and potential benefits of M&A

activity, stakeholders can navigate the ever-changing corporate landscape and capitalize on the opportunities these deals present.

The article "Pharma Mergers, Acquisitions Signal Underlying Shift in Drug Development" provides an in-depth analysis of the recent mergers and acquisitions in the pharmaceutical industry, shedding light on the evolving landscape of drug development. The article highlights that these changes signify a paradigm shift in the industry, as companies realign their business strategies to focus on differentiated products for which payers are willing to pay a premium. This shift is influenced by a push from Congress to speed up drug innovation, coupled with growing criticism over drug pricing. The report also delves into the staggering $250 billion worth of merger deals announced, as companies seek to discover the next blockbuster drugs and streamline their operations (Williams, 2015). The article emphasizes that the pharmaceutical and biotech industry, in response to the changing market dynamics, is focusing on cures for unmet needs and moving away from minimally differentiated product profiles. Industry analysts note that the recent activities reflect the companies' efforts to bolster their areas of strength and shed underperforming ones. Furthermore, the article predicts that the M&A activity will continue and even intensify, leading to a divide between top-tier and mid-size companies.

“Mergers and Acquisitions in the Pharmaceutical and Biotech Industries” Mark Danzona’ et al., 2007 examines the determinants and effects of M&A activity in the pharmaceutical/biotechnology industry using SDC data on 383 firms from 1988 to 2001 (Danzona’ et al., 2007). This research reveals that large companies encountering a surplus of production capabilities due to expiring patents and a lack of upcoming products tend to react by merging with other firms. On the other hand, for small firms, mergers are primarily an exit strategy in response to financial trouble. The calculated effects of mergers suggest that large firms that merged, experienced a similar change in enterprise value, sales, employees, and

R&D, and had slower growth in operating profit While some firms chose to merge, the success of similar firms that remained independent suggests mergers aren't always necessary for improvement. The paper also discusses the findings on the limitations of mergers as a solution to financial trouble in the pharmaceutical/biotechnology industry. Additionally, the paper provides insights into the reasons for mergers for large and small firms and the estimated effects of mergers on enterprise value, sales, employees, R&D, and operating profit growth. These findings contribute to understanding the dynamics of M&A activity in the pharmaceutical/biotechnology industry and provide valuable insights for firms operating in this sector (Danzona' et al., 2007). The research paper investigates the determinants and effects of M&A activity in the pharmaceutical/biotechnology industry from 1988 to 2001 using SDC data analysis of 383 firms. The study focuses on reasons for mergers for large and small firms and the estimated effects of mergers on enterprise value, sales, employees, R&D, and operating profit growth.

(Kumar, 2000) in their paper "Mergers and Acquisitions by MNEs: Patterns and Implications" published in Economic and Political Weekly, analyses the patterns and implications of mergers and acquisitions (M&As) by multinational enterprises (MNEs) in India. The paper highlights how M&As by MNEs play a significant role in concentrating market power, emphasizing the importance of competition policy in the context of liberalized foreign direct investment (FDI) inflows. It discusses the policy liberalization in India that facilitated M&As, contrasting the previous dominance of greenfield investments. The paper explains how MNEs' aggressive M&A strategies have led to increased market concentration in various sectors, particularly in services like advertising, travel agencies, and business services, as well as in industries like household appliances and pharmaceuticals. The paper "Factors behind the Performance of Pharmaceutical Industries in India" by Neogi, Kamiike, and Sato explores the changes in various policies related to trade and multinational company entry in

the Indian pharmaceutical industry, as well as the impact of these changes on industry growth and competitiveness. The paper focuses on analyzing the upswing in industry growth post-1991, the effect of pharmaceutical product patents on business opportunities and the competitive landscape, and how these changes influenced the entry and exit patterns of firms and plants in the market. The study highlights that policy changes related to trade and the entry of multinational companies into the Indian pharmaceutical industry were initiated in the early 1970s, but the industry's pace of growth significantly increased only after 1991. Specifically, the introduction of pharmaceutical product patents brought new business opportunities but also increased the threat of competition from emerging firms. The competitive pressure possibly induced the exit of small and inefficient firms and plants from the market. The study uses stochastic frontier analysis to estimate the efficiencies of individual plants in the Indian pharmaceutical industry using unit-level data covering the period 2000-2005 (Neogi et al., 2014).

(Deangelis, 2016) “Big Pharma Profits and the Public Loses” mentions how mergers and acquisitions within the pharmaceutical industry are examined as contributing factors to the high prices of drugs, which lead to reduced competition and subsequent price hikes. The paper provides a case study of the drug Daraprim, where the acquisition and subsequent price increases sparked public outcry. The paper also discusses the cost implications of delaying the release of cheaper generic drugs. The claim by pharmaceutical executives about the high cost of research and development is addressed, with skepticism raised about the validity of the data given the industry's funding of related studies. The author presents a strong case for increased transparency and regulatory measures to address the rising drug costs and their impact on public health. The findings emphasize the need for legislative action to potentially influence the conduct of pharmaceutical companies and protect the interests of the public.

The report (Williams, 2015) discusses the impact of M&A on shareholder value and how companies need to prioritize specific therapeutic areas to maximize profitability. It also points out that smaller companies may find increasing opportunities to partner with large drug manufacturers, presenting partnerships as a favorable pathway for disease-focused companies. (Danzona' et al., 2007) findings reveal that both large and small firms engage in M&A activity as a response to financial trouble, particularly related to patent expiration and expected excess capacity. Large firms with a low Tobin's q are more likely to engage in mergers, suggesting that acquirers value the target's assets more highly than the market. On the other hand, small firms with a relatively low Tobin's q are observed to be acquiring targets, indicating that the acquirer perceives advantages in growing larger. The study shows that mergers are more likely to be an exit strategy for small firms in financial trouble, as measured by low Tobin's q, few products, and low cash-sales ratios. Additionally, the analysis highlights that for both large and small firms, mergers do not necessarily lead to positive long-term outcomes. The study finds that M&A activity does not significantly affect growth in enterprise value, sales, employees, and R&D expenses in the years following a merger(Danzona' et al., 2007). For small firms, the post-merger integration may absorb the cash necessary to finance R&D, leading to slow growth in this area.

(Kumar, 2000) provides detailed examples of how MNEs have utilized M&As to enter and consolidate their presence in the Indian market. It explores the impact of M&As on market structure, competition, employment, and economic growth. The paper also discusses the implications of M&As on factors such as knowledge spillovers, market dominance, and employment, noting how MNEs have aggressively pursued M&As to strengthen their market presence and achieve dominance in various sectors. Furthermore, the paper accentuates the need for a comprehensive competition policy to address the anti-trust implications of M&As, particularly in facilitating fair competition, addressing market dominance, and preventing the

concentration of economic power. It also underscores the development implications of MNE-related M&As, highlighting the need for a competition policy that promotes healthy competition between local firms and MNE affiliates while promoting economic efficiency. In conclusion, the paper offers a comprehensive analysis of the patterns and implications of M&As by MNEs in India, emphasizing the need for a competition policy to address the anti-trust implications, promote healthy competition, and facilitate economic development. Overall, the research paper sheds light on the complex dynamics of M&As by MNEs and their implications for market structure, competition, and economic development in India. The findings (Neogi et al., 2014) indicate that higher managerial skill and better wage compensation are key factors driving the success of these facilities.The paper also explores the influence of ownership type, location, and plant size on the efficiency of pharmaceutical plants. The results of the analysis show that the efficiency of plants has increased over the years, with fluctuations, and that the level and growth of efficiencies differ significantly among different types of plant ownership. The study finds a positive association between the size of plants and their technical efficiencies, suggesting that economies of scale are prevalent in the Indian pharmaceutical industry. Moreover, the study reveals that private ownership has a significantly positive impact on the variation of efficiency of plants. The findings indicate that in the highly competitive pharmaceutical industry market, plants with low efficiencies are prone to merging with other plants or face the necessity to discontinue their operations.

Additionally, the study suggests that managerial skill, wage rates, plant size, and ownership type are crucial factors influencing the performance and efficiency of pharmaceutical plants in India. In “Structural Changes and Trade Competitiveness in the Indian Pharmaceutical Industry in Product Patent Regime” (Mahajan, 2019) a section titled “Impact of Mergers and Acquisitions” spoke about how M&As have become a notable trend, driven by the need to enhance global market presence and leverage cost and regulatory advantages. The

study underscores the potential of M&As to reconfigure the market dynamics, with bigger firms possibly absorbing smaller ones, thereby influencing the overall market structure and competitive equity within the industry. The paper concluded by saying, that while the product patent regime presents opportunities for growth and global competitiveness through innovation and M&As, it also poses substantial challenges. These include increased R&D expenditures, reliance on bulk drug imports, and the potential for reduced competition due to market consolidation. Future policies, as suggested by the study, should aim to harness the opportunities while mitigating the challenges to ensure a balanced development of the IPI in a manner that supports both innovation and competitive equity. The research underscores the importance of a strategic approach to policy formulation, aligning with the dynamic needs of the IPI in the product patent era.

2.8 CONCLUSION

2.8.1 The Indian Pharmaceutical Industry at a Crossroads

The literature review paints a complex picture of the Indian pharmaceutical industry, a sector brimming with potential but burdened by significant challenges. The industry has emerged as a global powerhouse in generics, transitioning from import dependence to a dominant export presence over the past few decades. This growth trajectory is attributed to several factors, including a skilled workforce, a robust production base, and a supportive regulatory environment that facilitated the flourishing of generic drug manufacturing.

However, the landscape is rapidly evolving, and the Indian pharmaceutical industry now finds itself at a crossroads. The implementation of stricter intellectual property regimes, particularly the enforcement of product patents post-TRIPS, has ushered in a new era with both opportunities and challenges. While this shift has spurred a much-needed focus on research and development (R&D) among major pharmaceutical firms, it has also led to a concerning

trend of market consolidation, potentially stifling competition and innovation from smaller players.

2.8.2 Maintaining Generic Leadership While Fostering Innovation

One of the critical challenges for the Indian pharmaceutical industry is to maintain its dominance in the generics market while simultaneously fostering domestic innovation for novel drug discovery. The industry has traditionally thrived on its ability to produce affordable generic versions of patented drugs, catering to a global market with a significant demand for cost-effective medicines. However, the ever-evolving regulatory environment and the increasing influence of multinational corporations necessitate a shift towards a more innovation-driven approach.

The literature review highlights the need for the Indian pharmaceutical industry to strike a delicate balance between generics production and new drug discovery. Continued investment in R&D is crucial for long-term sustainability and global competitiveness. The strategic shift observed among larger firms towards patenting new drugs is a positive step in this direction. However, fostering a culture of innovation across the industry, including among smaller and medium-sized enterprises, requires a multi-pronged approach. Government initiatives, such as tax breaks and subsidies for R&D activities, can incentivize innovation and empower smaller players to compete in the global market.

2.8.3 The Role of Intellectual Property and Collaboration

The enforcement of product patents under TRIPS has introduced a complex layer to the Indian pharmaceutical industry's operations. The literature review acknowledges the potential benefits of stricter intellectual property laws, such as increased foreign direct investment and technology transfer from multinational corporations. However, it also cautions against the potential drawbacks of excessively strong patent protection, which could stifle innovation and limit access to affordable medicines.

The path forward for the Indian pharmaceutical industry lies in navigating this intellectual property landscape strategically. Collaboration with international research institutions and pharmaceutical companies can provide valuable knowledge transfer and expedite the drug discovery process. Furthermore, the government can play a crucial role in creating a legal and regulatory framework that fosters innovation while ensuring access to essential medicines for domestic and international populations.

In conclusion, the Indian pharmaceutical industry stands at a crossroad. By addressing the challenges of fostering domestic innovation, reducing dependence on foreign raw materials, and navigating the complexities of the intellectual property regime, the industry can solidify its position as a global leader. Through strategic investments, collaborative partnerships, and a continued focus on affordability and accessibility, the Indian pharmaceutical industry has the potential to shape a healthier future for populations worldwide.

CHAPTER 3: METHODOLOGY

This study is anchored in international trade primarily, the Indian Pharmaceutical Industry has a very strong dataset fostered by various websites that allow easy analysis. The Indian pharmaceutical industry warrants study due to its extensive global reach. As the "pharmacy of the world," India supplies life-saving generic medicines to over 200 countries, making it a critical player in global health. Furthermore, this industry is a significant economic powerhouse for India, valued at over $50 billion and contributing substantially through jobs and exports. With a growing domestic market and strong export potential, the future of this industry is bright. Studying it can also provide insights into government policies that affect its growth, alongside challenges like intellectual property and fostering innovation. In short, understanding the Indian pharmaceutical industry is essential for ensuring continued access to affordable medicines, economic development, and advancements in global healthcare. The primary aim of this study is to present the overview, trade competitiveness, and policy implications of structural changes in Indian Pharmaceuticals, especially after the enactment of the Product Patent Act which includes market structure, ownership pattern, trade performance, R&D expenditure, and mergers and acquisitions. To study the causal link between R&D expenditure, exports, and the size of the pharmaceutical industry. The research aims to answer questions that, after being pieced together will solve the puzzle “What makes up the Indian Pharmaceutical Industry and what are the drivers?”

The first research question is about the transformation of the Pharmaceutical Industry In India. The IPI has undergone puberty since 1995. The introduction of product patents has fueled consolidation, raising questions about how this impacts competition and the variety of drugs available. Ownership patterns are also in flux, with potential shifts from domestic to foreign companies. This could influence research and development (R&D) investments and the

types of drugs being produced. Trade performance is another area of interest, with a focus on how the balance between exports and imports has changed. Understanding the drivers of export and import growth is crucial. Furthermore, the level and allocation of R&D expenditure within the industry merits examination. Finally, mergers and acquisitions (M&A) activity warrants analysis to understand the motivations behind them and their impact on the industry's competitive landscape. By exploring these aspects, we can comprehensively understand the Indian pharmaceutical industry's evolution.

This research paper also seeks to unveil whether the Pharmaceutical Trade is India's Greatest Strength. While strength can be shown with the magnitude of force, in international trade, exports are used as a proxy. Measuring the Normalised Revealed Comparative Advantage (NRCA) is a way of recognizing whether India has a comparative advantage in the manufacture of Pharmaceuticals among other products. The NRCA helps compare values across countries contrary to Revealed Comparative Advantage. Using that to the fullest, India's NRCA is compared to the top 10 major producer countries of pharmaceutical products. An attempt to compare and contrast India's NRCA with other countries to realize the title ‘Pharmacy of the developing world.’ The measurement of India’s Export-Import ratio is a sign of healthy export growth signified by a positive ratio. Firm-level data on profits after tax, total Income, and financial value of total exports provide us with a detailed ground-level analysis.

Analyzing the causal relationships that exist within the Indian pharmaceutical industry is very crucial for the smooth functioning and growth of the industry. Using the Granger Causality Test and Vector Autoregression (VAR) Model the dynamic relationship between factors like R&D expenditure, exports, and the size of the pharmaceutical industry and how these variables interact with each other over time is discussed in detail.

This research also attempts to inform policy decisions regarding the Indian pharmaceutical industry. Which existing policies have been most effective in supporting the

growth and innovation of the Indian pharmaceutical industry, and how can these policies be further optimized alongside new policy proposals, based on the research findings, what new policy measures could be implemented to address identified challenges and leverage opportunities for the Indian pharmaceutical industry is discussed.

Empowering stakeholders in the Indian pharmaceutical industry, via a competitive Landscape Analysis, Analyzing the key trends that shape the global pharmaceutical market, and realizing how Indian companies can adapt their strategies to remain competitive. Based on the research findings, what are the key risks and opportunities facing the Indian pharmaceutical industry?

This research adopts a descriptive, historical approach to analyze the evolution of the Indian pharmaceutical industry from 1992-93 to 2022-23. This study primarily uses a quantitative approach but at the same time uses a qualitative approach to explain the quantitative data, therefore while the major chunk of the research is filled with quantitative data there is a tiny bit of qualitative data in it so if a one-word answer was to justify this data type, I'll say Mixed method. The research seeks to uncover a lot of answers that can only be achieved using quantitative data from the NRCA, VAR models, Pairwise Granger Causality test, and so on. As the objectives of this paper suggest the ball of these quantitative data were set rolling by policies or Mergers & Acquisitions, which help explain the findings of the quantitative data and or vice versa.

3.1 DATA SOURCES

This research focuses on the Indian Pharmaceutical Industry, inclusive of domestic production as well as exports, in other words, while we look at the domestic functioning of the industry we also look at the international trade. The study will leverage secondary data, meticulously gathered from the sources,

1. Prowess IQ, by the Center for Monitoring of Indian Economy (CMIE), Prowess Database: A paid software that Goa University subscribes to, a privately managed database with a huge amount of financial data for a massive time frame.

Raw Data Downloaded: Profits after Tax, Total Exports, Total Income for 940 IPI companies from 1992-2023. M&A, Year-wise Sales, Exports, R&D Capital, and R&D Current Expenditure for 936 companies of the IPI from 1992-2023. Firm-level data of all the IPI.

2. Company reports: for company-specific data required, or excess data required to support the existing.
3. WITS: World Integrated Trade Solutions, a free-to-use database that provides data on international trade based on HS classification among others, for most countries including groups like ASEAN, NAFTA, and others.

Raw Data Downloaded: Pharmaceutical Exports and Imports of the IPI, India's Total Exports and Total Imports. The total Trade, Total Pharma Exports, and Total Exports of all products of Germany, China, Japan, Ireland, Italy, India, Belgium, France, USA, and Switzerland including the entire world.

4. Pharmexil Annual Reports; The Pharmaceutical Export Promotion Council of India, set up by the Ministry of Commerce and Industry, Government of India. The annual report provides data about the industry, and everything about the industry, the 90-page document is a well-drafted well-compiled report.

3.2 DATA SOUGHT

The research while it is compared to other countries, is based on the pharmaceutical industry of India. The study is carried out for the years 1992 to 2023, these specific years as they have seen the pre and post-liberalization movement, the pre and post-TRIPS agreement, and also the pre and post-COVID-19 pandemic.

3.3 DATA ANALYSIS

The statistical analysis was carried out by three software,

Table 3.1. Summary Table of Analytic Tools

Software	**Type of Analysis**	**Formula**
Excel	Concentration Ratios	*CRn=* $(\Sigma Market\ Share)/$ 100
	Herfindahl–Hirschman index	HHI= $\Sigma(Market\ Share)^2$
	Top 10 Pharmaceutical Companies of India by Market Capitalization (as of 1st April 2024) and their percentage share of Profits after tax, Total Income, Total export	*Share= (Company's Export/Industries total) *100*
	Percentage share of India's Pharma Exports in the country's total exports	*Share= (India's Export of Pharma)/(India's Total Exports)*
	Percentage share of India's Pharma Exports in the global pharma exports	*Share= (India's Export of Pharma)/(Worlds Total Pharma Exports)*
	Export/Import Analysis	*Ex-Im= Exports/Imports*
	Normalized Revealed Comparative Advantage	*NRCA= (Countries Pharma Ex/WorldsTotal Trade)-(Worlds Pharma Ex * Countries total Exports/Worlds Total Exports * Worlds Total Exports)*
	NRCA of top 10 major pharma-producing countries	
RStudio	Pairwise Granger Causality Test	*Run using commands on the software*
EViews 12	Vector Autoregressive Model	

3.4 CONCENTRATION RATIO AND HERFINDAHL HIRSCHAM INDEX

Concentration ratios (CR) and the Herfindahl-Hirschman Index (HHI) are metrics used to measure the level of competition within an industry. They both aim to quantify how concentrated market share is among the largest firms. Here's a breakdown of each:

3.4.1 Concentration Ratios (CR)

A CRn represents the combined market share of the top N firms in an industry. Common examples include CR4 (top 4 firms) and CR8 (top 8 firms).

Calculation: Sum the market shares of the top N firms.

a. *Interpretation:* A higher CR indicates a more concentrated market, meaning a few firms control a large portion of the market share. Conversely, a lower CR suggests a more competitive market with many players. There's no single threshold to define a "competitive" or "concentrated" market. Regulatory bodies often use CRs alongside other factors when evaluating competition concerns.

3.4.2 Herfindahl-Hirschman Index (HHI)

The HHI considers not just the number of large firms but also the relative size difference between them. It squares the market share of each firm and then sums them up.

Calculation: HHI = Σ(market share of each firm)^2 (summation symbol represents adding all firms)

a. *Interpretation:* Similar to CR, a higher HHI indicates a more concentrated market.

Here are some general interpretations of HHI values:

Below 0.01: Likely a competitive market

0.09 to 0.1: unconcentrated market

0.1 to 0.18: Moderately concentrated market

Above 0.18: Highly concentrated market

3.4.3 Benefits of Calculating Concentration Ratios and HHI

a. *Simple to calculate:* Both CR and HHI require readily available data (market share of firms).

b. *Provide a snapshot of market concentration:* They offer a quick way to assess the level of competition within an industry. Useful for policy analysis: Regulatory bodies use them to evaluate mergers and acquisitions and potential anti-competitive practices.

3.4.4 In Conclusion

Concentration ratios (CR) and the Herfindahl-Hirschman Index (HHI) are valuable tools for assessing market competition. While they have limitations, they offer a simple and informative way to gauge how concentrated market share is among the largest firms in an industry. These metrics are used by businesses, policymakers, and researchers to understand market dynamics and potential concerns

3.5 TOP 10 PHARMACEUTICAL COMPANIES OF INDIA BY MARKET CAPITALIZATION (AS OF 1ST APRIL 2024) AND THEIR PERCENTAGE SHARE OF PROFITS AFTER TAX. TOTAL INCOME. TOTAL INCOME. TOTAL EXPORT

3.5.1 Performance Assessment

By calculating these percentages for each major company and aggregating them, you can assess the relative contribution of these companies to the overall profitability, revenue generation, and export performance of the entire Indian pharmaceutical sector. This assessment helps in understanding which companies are driving profitability, revenue growth, and export competitiveness within the industry.

3.5.2 Benchmarking and Comparison

Comparing the performance metrics (profits after tax, total income, total exports) of individual companies against the industry's total allows for benchmarking and identifying leaders and laggards in the industry. It helps identify companies that are outperforming or underperforming compared to industry averages or standards.

3.5.3 Industry Insights and Trends

Analyzing these percentages over time provides insights into industry trends and dynamics.

For example, an increasing share of profits after tax from a few dominant players may indicate consolidation or market concentration within the industry.

3.5.4 Investor and Stakeholder Perspective

Investors and stakeholders, including shareholders and financial analysts, use these metrics to assess the financial health, growth potential, and market position of individual companies.

Understanding which companies contribute significantly to overall industry profitability and export earnings helps in making informed investment decisions.

3.5.5 Policy and Strategy Formulation

Policymakers and industry stakeholders use such data to formulate policies and strategies to promote growth, innovation, and competitiveness within the pharmaceutical sector. Insights from these calculations can guide initiatives aimed at supporting and nurturing high-performing companies while addressing challenges faced by others.

3.5.6 Risk Management and Planning

Understanding the distribution of profits, income, and exports among major players in the industry aids in risk management and strategic planning. Diversification strategies, supply chain optimization, and market expansion plans can be informed by this analysis.

3.5.7 Overall Industry Health

The calculated percentages provide a snapshot of the overall health and performance of the Indian pharmaceutical industry. Monitoring these metrics over time helps in assessing the industry's resilience to economic fluctuations, regulatory changes, and global market conditions.

In summary, calculating and analyzing the percentage share of profits after tax, total income, and total exports from major companies within the Indian Pharmaceutical Industry is essential for performance evaluation, benchmarking, strategic decision-making, and policy formulation. It offers valuable insights into industry dynamics, competitiveness, and growth

prospects, benefiting various stakeholders including investors, policymakers, and industry participants.

3.6 INTERNATIONALIZATION AND GROWTH

This section of the Analysis fosters the VAR model as well as the Pairwise Granger Causality test. Both tests use a dataset from the CMIE's Prowess IQ database that includes 4 variables,

3.6.1 Pharmaceutical Sales

Pharmaceutical sales refers to the selling and promotion of prescription and non-prescription medications and other medical products to healthcare professionals, such as doctors, pharmacists, and hospitals, and then eventually in the hands of the general public. Pharma Sales is a key metric for pharmaceutical companies as it reflects the success of their products in the market. It is used to track performance, make strategic decisions, and measure the return on investment for research and development.

3.6.2 Pharmaceutical Exports

Pharmaceutical exports refer to the international trade of pharmaceutical products from one country to another. This involves the sale and shipment of medications, vaccines, medical devices, and other related healthcare products manufactured by pharmaceutical companies in one country to buyers or distributors in other countries. Pharmaceutical exports play a significant role in improving access to essential medications, supporting public health initiatives, and driving economic growth in both exporting and importing countries. Therefore, effective export strategies require careful planning, regulatory expertise, and continuous adaptation to market conditions and industry trends.

3.6.3 Research and Development (Current+Capital)

Research and Development (R&D) is a critical component of the pharmaceutical industry that involves the discovery, development, and testing of new medications and

treatments. It is a complex and resource-intensive process aimed at advancing medical science, improving patient outcomes, and addressing unmet medical needs. Research and Development is fundamental to the advancement of the pharmaceutical industry, translating scientific discoveries into life-changing therapies that benefit patients worldwide. Despite challenges and complexities, ongoing investments in R&D continue to drive medical progress and shape the future of healthcare. Investing in Research and Development (R&D) is crucial for various reasons, particularly in industries like pharmaceuticals. Here are several key reasons why R&D investment is important:

1. Innovation and Competitive Edge: R&D investment fuels innovation, driving the development of new products, technologies, and processes. This innovation is essential for staying competitive in rapidly evolving markets. Companies that invest in R&D can introduce novel drugs, therapies, and medical devices that differentiate them from competitors and capture market share.
2. Addressing Unmet Medical Needs: R&D enables the discovery and development of treatments for diseases with significant unmet medical needs. By investing in R&D, pharmaceutical companies can tackle complex health challenges, develop breakthrough therapies, and improve patient outcomes.
3. Long-Term Growth and Sustainability: R&D investments contribute to long-term growth and sustainability by expanding product pipelines and diversifying revenue streams. New innovations developed through R&D can drive future revenue growth and offset the decline of older products facing patent expirations or generic competition.
4. Improving Health Outcomes: Investing in R&D leads to the development of safer, more effective treatments and medical technologies that enhance public health. Breakthroughs in R&D can transform the standard of care, extend life expectancy, and improve the quality of life for patients.

5. Stimulating Economic Development: R&D investments create jobs, support scientific research institutions, and stimulate economic growth. The pharmaceutical industry, in particular, is a major contributor to economic development through investments in research, manufacturing, and healthcare services.
6. Compliance and Regulatory Requirements: R&D investments are necessary to meet stringent regulatory requirements governing drug development and approval. Adequate investment ensures compliance with safety, efficacy, and quality standards set by regulatory agencies.
7. Adapting to Market Trends and Customer Needs: R&D helps companies adapt to changing market dynamics, emerging healthcare trends, and evolving customer preferences. By investing in R&D, companies can anticipate future market demands and develop innovative solutions that meet customer needs.
8. Intellectual Property Protection: R&D investments contribute to the creation and protection of intellectual property (IP) assets such as patents, trademarks, and trade secrets. Strong IP protections provide companies with a competitive advantage and incentivize continued innovation.
9. Collaboration and Partnerships: R&D investments facilitate collaboration with academic institutions, research organizations, and industry partners. Collaborative R&D efforts leverage diverse expertise and resources to accelerate scientific discoveries and bring new treatments to market.
10. Public Perception and Corporate Responsibility: Investing in R&D demonstrates a commitment to scientific advancement, patient care, and corporate responsibility. It enhances the company's reputation as an innovative leader in the healthcare industry.

In summary, investing in R&D is essential for driving innovation, addressing medical challenges, sustaining growth, and improving health outcomes. It fosters competitiveness,

stimulates economic development, and reinforces the industry's commitment to advancing healthcare for the benefit of society as a whole.

The key difference between R&D capital expenditure and R&D current expenditure lies in their nature and how they are treated in financial accounting.

a. *R&D Current Expenditure:* Represents the day-to-day operational costs of research and development. These are expenses that are used up in the current accounting period and don't provide any long-term benefits. Examples include salaries of researchers, and technicians, materials for experiments, software licenses for simulations, and utilities used in R&D labs. They are treated as operating expenses and are deducted from a company's revenue to determine net income in the current year.

b. *R&D Capital Expenditure:* Represents investments in assets that will be used for R&D activities for multiple years.

   These are long-term assets expected to contribute to future innovation.

Examples include purchasing specialized research equipment (like a supercomputer or a pilot plant), building or renovating R&D facilities, and acquiring intellectual property (patents or licenses). They are not expensed immediately but are capitalized on the company's balance sheet. The cost is then spread out over the asset's useful life through depreciation, which is reflected as an expense each year.

Table 3.2. Dataset Containing R&D Capital and Current Expenditure With Pharma Sales and Pharma Exports to Be Used In the Pairwise Granger Causality Test and the VAR Model

Year	Pharma Sales (Rupees Million)	Pharma Exports (Rupees Million)	R&D Capital Expenditure (Rupees Million)	R&D Current Expenditure (Rupees Million)
1992	51880.8	5997.1	26.7	115.7
1993	63619.3	6736.1	161.4	412.4
1994	83304.8	10780	482.8	607.3
1995	105425.6	15868.4	802.9	759.5
1996	124242.1	22317	851.9	918.4
1997	132124.5	25778.9	619.9	1194.3
1998	150833.3	31302.7	559.3	1369.5
1999	182201.6	34856.6	990.3	1544.4
2000	208004.4	42860	974.1	2193.4
2001	232807.5	53130.6	2122.9	3202.5
2002	258816.2	69593.4	1925.9	4749.6
2003	311772.7	94853.7	2067.9	6527.7
2004	369657.2	119528.4	3660.8	10109.9

2005	402640.8	134651.4	4920.2	13794.2
2006	479768.9	161055.8	7363.9	18228.3
2007	602922.1	220250.8	7218	21723.9
2008	702060.1	260787.4	9205.9	26409.5
2009	833519.9	323063.4	9332	31455.3
2010	954395.7	367611.6	7722.6	36665.4
2011	1146037.2	431788.5	9936.9	43719
2012	1343584.7	549534.8	10314.8	49096.4
2013	1499801.2	655168.1	9712.8	57416.4
2014	1902827.1	831938.4	9356.2	75078.6
2015	2085415.9	919502.2	9545.6	88106.4
2016	2342732.8	954415.2	15581.2	105003.1
2017	2431672.1	509118.7	21207.4	125712.6
2018	2571315.8	418276.7	11867.6	120627.3
2019	2941748	460386.9	11688.5	126477.7
2020	3227091.1	487613.9	9864	132004.9
2021	3715417.5	576502.4	14086.7	149793
2022	4344149.7	653144.7	20038.8	164111.8

2023	3443418.8	731396.3	16973.7	155502.7

(Source: CMIE's, Prowess IQ, The Indian Pharmaceutical Industries Total Pharmaceutical Sales, Pharmaceutical Exports, R&D Capital Expenditure and R&D Current Expenditure for the years 1992-2023)

The data shows that the pharma sales in India have increased significantly over the past 31 years. Pharma sales have grown from 51,880.8 million rupees in 1992 to 4,344,149.7 million rupees in 2022. Pharma exports have also increased significantly, from 5,997.1 million rupees in 1992 to 653,144.7 million rupees in 2022.

There seems to be a drop in pharma sales in 2023 to 3,443,418.8 million rupees. It is difficult to say from the data why this might have happened.

R&D capital expenditure has also increased over the years, from 26.7 million rupees in 1992 to 20,038.8 million rupees in 2022. There is a similar drop in R&D capital expenditure in 2023 to 16,973.7 million rupees.

These insights are very necessary to the study since the dataset includes data from 1992-2023 which is 31 years, the IPI has seen a lot of change, the difference between 1992-2023 for Sales is ₹-3391538 million, ₹-725399.2 million for Pharma Exports, R&D Capital Expenditure sees ₹-16947 million different and a difference of ₹-155387 million in R&D Current expenditure. This minor analysis is a sign of how the numbers have taken a huge leap and this difference leads to a greater value of Standard Deviation and Errors which we shall look at in the next sub-topic.

3.7 PAIRWISE GRANGER CAUSALITY TEST

The pairwise Granger causality test is a statistical method used to assess whether one-time series variable can predict another time series variable. In simpler terms, it helps us

understand if past values of one variable (in this case R&D Capital Expenditure) can be used to statistically improve the forecast of another variable (Pharma Exports).

Here's a breakdown of the key points:

3.7.1 Pairwise

This means the test focuses on the relationship between two-time series variables at a time. It doesn't consider the influence of other variables that might be affecting them.

Granger Causality: This refers to a specific type of causality where one variable precedes and influences another. It doesn't necessarily imply a direct cause-and-effect relationship, but rather a predictive power.

3.7.2 Prediction

The test essentially builds two models to forecast Pharma Exports. One model only uses past values of Pharma Exports (itself), while the other model includes both past values of Pharma Exports and past values of R&D Capital Expenditure. The test then compares the accuracy of these forecasts.

3.7.3 Importance of the Pairwise Granger Causality Test

This test is important, particularly in the Pharmaceutical industry, an industry where R&D expenditures are very high and very necessary, so the test helps us:

3.7.4 Identify Potential Relationships

It can reveal if changes in one variable seem to be followed by changes in another, suggesting a potential influence. For instance, if investment in R&D capital Expenditure leads to increased exports, a more informed decision can be made about investments and the volume of investments.

3.7.5 Inform Further Analysis

By understanding which variables might be predictive, researchers can explore the underlying mechanisms and potentially build more complex models that account for these relationships.

3.7.6 Avoid Spurious Correlations

Correlation doesn't always equal causation. The test helps distinguish if the observed relationship between variables is truly predictive or just coincidental.

Overall, the pairwise Granger causality test is a valuable tool for exploratory data analysis in time series data. It can help identify potential relationships between variables and guide further investigation into the underlying mechanisms at play.

3.8 VECTOR AUTOREGRESSION MODEL

The study used the VAR model to analyze the causal relationships as well as inter-relationships among the variables. The key reason for using the VAR model is that the autoregression indicates that variables will be regressed on their own past values. This would help analyze the impact of the previous year's sales, exports, and disaggregated R&D spending on the current and future levels of these parameters. Also, in a time series analysis, the VAR model helps in understanding a relationship amongst variables that changes through time which may not be possible through linear regression. In this study, sales have been taken as an exogenous variable with a lag of 1 year. This is so because total sales encourage a firm to explore export markets and invest in R&D to develop new products.

3.8.1 VAR Lag Order Selection Criteria

a. *LogL (Log Likelihood):* This measures the fit of the model. Higher values indicate a better fit. However, it penalizes the number of lags included in the model, so it's not ideal for direct comparison across different lag lengths. The table shows 'NA' for Lag 0, likely because it's not a valid lag order for comparison.

b. *LR (Likelihood Ratio):* This statistic tests whether additional lags improve the model fit compared to a model with fewer lags. An asterisk (*) next to the value indicates statistical significance at a pre-defined level (e.g., 5%). In this case, Lag 1 has an asterisk, suggesting it significantly improves the model fit compared to the model with no lags (Lag 0).

c. *FPE (Final Prediction Error):* This criterion aims to estimate the mean forecasting error of the model. Lower values indicate better forecasting performance. An asterisk (*) indicates the minimum FPE value across the lags shown. The table doesn't display asterisks for FPE.

d. *AIC (Akaike Information Criterion):* and SC (Schwarz Criterion): These criteria combine the goodness of fit (measured by LogL) with a penalty for model complexity (number of lags). Lower AIC and SC values are preferable. An asterisk (*) indicates the minimum AIC or SC value. The table also doesn't display asterisks for AIC or SC.

3.8.2 Var Residual Serial Correlation Lm Tests

The results of the VAR Residual Serial Correlation LM Tests show that the null hypothesis of no serial correlation cannot be rejected for any of the lags (1, 2, and 3) at the 5% significance level.

a. *Lag*: This refers to the number of periods lagged in the residuals. For example, lag 1 tests for serial correlation in the residuals of the previous period (t-1) with the current residuals (t).

b. *LM-stat:* This is the LM (Lagrange Multiplier) statistic, which is used to test the null hypothesis of no serial correlation.

c. *Prob:* This is the p-value associated with the LM statistic. A low p-value (typically below 0.05) indicates that the null hypothesis can be rejected, suggesting the presence of serial correlation at that lag.

3.8.3 Residual Normality Tests

In Vector Autoregression (VAR) models, VAR Residual Normality Tests specifically focus on whether the model's residuals are normally distributed. Normality is an important assumption for VAR models, as it allows for more reliable statistical tests and inference. These tests aim to answer: Do the residuals behave like random noise with a bell-shaped distribution?

3.8.4 Var Residual Heteroskedasticity Tests (Levels And Squares)

VAR Residual Heteroskedasticity Tests diagnose a potential issue called heteroskedasticity. This fancy term simply means the variance (spread) of the residuals is not constant across all observations.

a. *Levels Tests:* These tests assess whether the variance of the residuals themselves is constant over time. Unequal variance in the residuals can lead to unreliable standard errors and significance tests.
b. Squares Tests: These tests focus on whether the variance of the squared residuals (the errors squared) is constant. This can be an indicator of non-linearities in the relationships between the variables.

3.8.5 Var Granger Causality/Block Exogeneity Wald Tests

VAR models allow us to test for causal relationships between multiple time series variables. Here's a quick look at two key tests:

a. *Granger Causality (Wald Test):* This tests if past values of one variable (R&D Capital Expenditure) significantly improve the prediction of another variable (Pharmaceutical Exports) compared to a model using only Pharmaceutical Exports's past. In simpler terms: Does knowing the R&D Capital Expenditure history help predict Pharmaceutical Exports better?
b. *Block Exogeneity (Wald Test):* This is another version of the Granger Causality test, but instead of focusing on individual variables (R&D Capital Expenditure), it tests if a

group of variables can be treated as exogenous (not influenced by the other variables) for a specific equation in the VAR model.

3.8.6 Impulse Response Test

An impulse response test measures how a system responds to a sudden shock or change in one variable. In a VAR model context, it can be used to understand how a model predicts the impact of a one-time change in one variable on all the other variables over time.

3.8.7 Varriance Decomposition Test

Variance decomposition is a statistical method used to analyze how much of the variation in a variable can be explained by variations in other variables. In the context of economics, it can be used to see how much of the variability in one economic variable is caused by shocks to other economic variables.

3.9 PERCENTAGE SHARE OF INDIA'S PHARMACEUTICAL EXPORTS IN INDIA'S TOTAL EXPORTS AND PERCENTAGE SHARE OF INDIA'S PHARMACEUTICAL EXPORTS IN WORLD PHARMACEUTICAL EXPORTS

Understanding these percentages is crucial for analyzing the strength and potential of India's pharmaceutical industry. The first percentage tells us how much pharmaceutical exports contribute to India's overall export economy. A high percentage indicates India is a major player in exporting pharmaceuticals, while a low percentage might suggest there's room for growth in this sector. The second percentage reveals India's position on the world stage. A significant share signifies India as a global leader in pharmaceutical exports, while a smaller share might indicate there's more competition to overcome. By knowing both figures, we can assess India's current standing, identify areas for improvement, and track progress in achieving dominance in the global pharmaceutical market.

3.10 INDIAN PHARMA EXPORT-IMPORT RATIO OF PHARMA PRODUCTS

Calculating India's Pharmaceutical Export-Import Ratio of Pharma Products is a valuable step because it sheds light on India's self-sufficiency and role in the global pharmaceutical market. By analyzing this ratio, you can understand India's position in the pharmaceutical landscape and identify areas for potential growth. It can inform strategies to increase domestic production, reduce reliance on imports, or explore opportunities for further expansion in global pharmaceutical exports.

3.11 NORMALIZED REVEALED COMPARATIVE ADVANTAGE

Normalized Revealed Comparative Advantage (NRCA) is a metric used in international trade analysis to assess a country's comparative advantage in exporting specific commodities. It builds upon the traditional Revealed Comparative Advantage (RCA) but addresses some of its limitations.

3.11.1 Comparative Advantage

This concept suggests that countries tend to export goods that they can produce more efficiently (at a lower relative cost) compared to other goods.

3.11.2 What NRCA Helps Calculate

a. *Symmetrical Measure:* Unlike RCA, NRCA provides a symmetrical value between -1 and 1. A value closer to 1 indicates a strong comparative advantage in exporting a particular good, while a value closer to -1 suggests a comparative disadvantage. 0 represents no advantage or disadvantage.

b. *Cross-Country & Product Comparability:* NRCA facilitates comparisons between different countries and different products because it considers the overall trade structure of a country. This is an improvement over RCA, which can be difficult to compare across countries with vastly different economies.

3.11.3 Why NRCA is Required

a. *Overcomes Limitations of RCA:* NRCA addresses the issue of asymmetry in RCA, making it easier to interpret and compare results.
b. *Improved Cross-Analysis:* It allows for a more balanced analysis of comparative advantage across countries and products.
c. *Focus on Revealed Trade Patterns:* NRCA remains grounded in actual trade data, reflecting a country's revealed comparative advantage based on its export patterns.

In essence, NRCA provides a more nuanced and comparable way to assess a country's export strengths and weaknesses, aiding policymakers and businesses in making informed decisions about trade strategies and resource allocation.

CHAPTER 4 ANALYSIS

4.1 CONCENTRATION AND COMPETITION

This section of the analysis deals solely with the competition in the domestic pharmaceutical market, the IPI has 940 registered companies (according to the Prowess IQ database) which over the years have found their place in the market, the competition that existed in 1992 with limited companies is no longer the scenario.

4.1.1 Concentration Ratio And Herfindahl Hirschman Index

Table 4.1. CR4, CR8, and HHI from 1992-2023

Year	CR4	CR8	HHI
1992	26.58459392	37.36141309	0.029960398
1993	25.41807282	36.56154657	0.028612331
1994	25.69251712	36.29766832	0.028227372
1995	22.73802568	32.85539755	0.024308944
1996	21.3552411	30.78569986	0.021950448
1997	21.96572172	32.03841831	0.023421312
1998	22.15505462	32.41227236	0.023665627
1999	17.97020443	28.21687625	0.018007864
2000	19.65117084	29.33322564	0.019732348
2001	20.77832544	33.15232542	0.021969178
2002	23.53793928	36.14039616	0.024578002

2003	24.07035638	36.74693134	0.026801857
2004	24.45822779	36.46013117	0.02679599
2005	23.33563812	34.70254381	0.024646749
2006	21.38414974	33.39328581	0.021441683
2007	22.40005798	33.94778529	0.021898313
2008	20.26672645	32.16958206	0.019816304
2009	20.16495347	31.31864038	0.019134249
2010	19.84816151	29.43417494	0.01807588
2011	19.28686085	29.49752416	0.017724325
2012	20.05416555	30.26990409	0.018628273
2013	19.93881589	31.22232467	0.01919733
2014	18.71754927	30.24994756	0.017733348
2015	18.42929748	31.09453131	0.018220507
2016	18.42344547	31.5975471	0.018931011
2017	17.77592053	30.95375812	0.018024036
2018	16.10403903	28.29309025	0.016035863
2019	15.97377138	28.19116729	0.01570182
2020	16.1269262	28.36456337	0.015998467
2021	15.60286563	27.17206074	0.015119822

2022	16.38546664	27.19583305	0.015955804
2023	19.27525342	32.08522878	0.021448055

(Source: CMIE, Prowess IQ database, CR, and HHI calculated by the researcher)

a. *Overall Trend*

1. Concentration: There appears to be a general downward trend in concentration since 1992. Both CR4 and CR8 values have decreased over time, suggesting an increasing number of firms holding significant market share. This could indicate growing competition in the Indian pharmaceutical industry.
2. *HHI:* Similarly, the HHI generally falls throughout the years, supporting the notion of declining market concentration. However, there are some fluctuations, suggesting periods of consolidation or shifts in market dynamics.

b. *Year-by-Year Analysis*

1. *1992-1999:* High concentration with large CR4 and CR8 values (above 25% and 30% respectively) and higher HHI, indicating dominance by a few firms.
2. *2000-2010:* Gradual decline in concentration, with CR4 and CR8 dropping below 25% and 35% respectively, and HHI falling as well. This suggests increasing competition.
3. *2011-2020:* Concentration remains relatively stable, with slight fluctuations in CR and HHI values. This period might be characterized by balanced competition within the industry.
4. *2021-2023:* Slight increase in concentration, potentially due to specific market events or mergers. This needs further investigation to understand the underlying cause.

c. *Specific observations*

In 1992, the CR4 was 26.58%, meaning the top 4 firms held over a quarter of the market share. This indicates a moderately concentrated market at that time. By 2023, the CR4 had

decreased to 19.28%, suggesting a more competitive market with a wider distribution of market share.

The HHI also shows a similar trend, decreasing from 0.0299 in 1992 to 0.0214 in 2023. This reinforces the notion of declining concentration. However, there are some years with fluctuations, such as the increase in CR4 and HHI in 2003 and 2023. These might be due to specific events or mergers that require further investigation.

4.1.2 Top 10 Pharmaceutical Companies Of India By Market Capitalization (As Of 1st April 2024) And Their Percentage Share Of Profits After Tax, Total Income, Total Export.

The table below aims to show ground-level data about how much a company realistically contributes to the IPI, calculating the percentage share of Profits after tax, Total Income, and Total exports each from the Industries total respective has many benefits,

Table 4.2. Top 10 Pharmaceutical Companies of India by Market Capitalization (as of 1st April 2024) and Their Percentage Share of Profits After Tax, Total Income, Total Export.

Year	Type Of Share	Sun Pharmaceutical Inds. Ltd.	Cipla Ltd.	Dr. Reddy'S Laboratories Ltd.	Zydus Lifesciences Ltd.	Torrent Pharmaceuticals Ltd.	Lupin Ltd.	Aurobindo Pharma Ltd.	Alkem Laboratories Ltd.	Abbott India Ltd.	Glaxosmithkline Pharmaceuticals Ltd.
1992	Profit After Tax	0.000	5.029	6.259	0.000	2.015	0.000	0.000	0.000	3.610	3.014
	Total Income	0.000	2.919	2.002	0.000	1.410	0.000	0.000	0.000	2.272	9.408
	Total Export	0.000	2.959	2.622	0.000	0.000	0.000	0.000	0.000	0.716	2.456
1993	Profit After Tax	0.000	3.851	7.631	0.000	5.241	0.353	0.773	0.000	2.204	3.840
	Total Income	0.000	3.149	2.050	0.000	2.522	0.050	0.400	0.000	2.303	8.654
	Total Export	0.000	2.963	3.706	0.000	0.000	0.000	0.302	0.000	0.227	2.096
1994	Profit After Tax	1.272	2.498	4.310	0.000	3.014	1.376	0.470	0.000	1.380	4.069
	Total Income	0.622	2.880	2.014	0.000	2.590	0.518	0.447	0.000	2.070	9.237
	Total Export	0.234	2.232	3.846	0.000	0.000	0.000	0.954	0.000	0.156	1.856
1995	Profit After Tax	2.520	3.355	4.703	0.000	2.755	0.239	0.709	0.000	0.848	21.757

	Total Income	0.856	2.746	1.833	0.000	2.197	0.545	0.778	0.000	2.155	10.278
	Total Export	0.267	1.950	4.007	0.000	0.000	0.000	1.586	0.000	0.057	1.615
1996	Profit After Tax	3.469	2.717	4.706	0.402	3.098	0.356	0.668	0.000	0.947	17.363
	Total Income	1.039	2.792	1.777	1.647	2.506	0.529	0.922	0.000	1.609	8.686
	Total Export	0.255	1.776	3.144	1.171	0.000	0.000	2.158	0.000	0.004	1.147
1997	Profit After Tax	7.758	11.185	5.328	1.132	5.693	1.085	2.013	0.000	3.238	7.573
	Total Income	1.442	3.488	1.843	1.605	2.623	0.672	1.624	0.000	2.025	5.340
	Total Export	0.337	2.387	2.711	0.769	0.282	0.005	3.503	0.000	0.000	0.951
1998	Profit After Tax	14.620	27.329	13.090	5.486	10.908	2.929	6.376	0.000	13.384	11.039
	Total Income	1.858	3.456	2.141	1.925	2.530	0.708	1.896	0.000	2.011	5.037
	Total Export	1.140	2.323	3.564	0.890	3.430	0.013	2.999	0.000	0.026	1.418
1999	Profit After Tax	17.995	35.035	15.776	9.253	11.082	3.807	15.279	3.188	8.241	26.407
	Total Income	1.962	3.434	2.312	1.897	1.933	0.612	2.942	1.423	1.654	4.883
	Total Export	1.777	3.336	3.395	0.881	0.796	0.000	6.181	0.151	0.097	1.862
2000	Profit After Tax	7.327	11.654	5.283	3.301	3.992	0.831	6.534	1.040	6.000	6.749
	Total Income	2.286	3.673	2.320	2.124	2.082	0.345	3.477	1.538	1.733	4.401
	Total Export	1.288	3.280	3.047	0.895	2.564	0.281	8.569	0.224	0.066	1.732
2001	Profit After Tax	8.455	11.200	9.036	4.101	2.592	3.250	4.272	3.306	4.517	4.412
	Total Income	2.399	4.516	4.192	2.131	1.699	3.407	4.192	1.659	1.820	4.143
	Total Export	2.134	4.861	8.086	1.132	0.536	4.224	10.255	0.232	0.061	1.360
2002	Profit After Tax	7.798	9.601	21.255	3.103	2.306	3.338	3.168	0.000	2.252	2.272
	Total Income	2.637	5.304	6.251	2.139	1.886	3.267	3.943	0.000	1.450	4.680
	Total Export	1.921	7.101	13.298	1.219	0.453	4.343	6.991	0.000	0.024	1.062
2003	Profit After Tax	9.012	9.648	15.270	2.983	2.017	2.846	4.017	2.605	2.233	3.819
	Total Income	2.495	4.954	5.109	3.156	1.282	3.138	3.763	1.595	1.370	3.839
	Total Export	1.476	5.957	9.675	1.086	0.403	4.225	5.933	0.323	0.017	0.611
2004	Profit After Tax	7.247	8.903	8.530	4.304	1.933	2.864	3.826	2.620	2.081	5.187
	Total Income	2.638	5.425	4.729	3.163	1.286	3.200	3.537	1.554	1.210	3.366
	Total Export	1.707	6.793	8.208	1.483	0.376	4.756	5.369	0.330	0.017	0.287
2005	Profit After Tax	8.094	10.818	1.729	3.470	1.398	2.173	0.927	2.527	2.701	8.797

	Total Income	3.123	5.929	4.090	2.886	1.303	2.940	2.808	1.520	1.266	3.989
	Total Export	2.042	7.818	6.784	1.024	0.600	4.022	4.117	0.347	0.020	0.211
2006	Profit After Tax	9.310	12.263	4.261	3.328	1.329	3.613	1.400	2.820	1.194	10.133
	Total Income	3.717	6.396	4.630	2.749	1.487	3.427	2.986	1.636	0.960	3.736
	Total Export	2.267	9.394	7.427	1.287	0.834	4.724	5.066	0.293	0.021	0.170
2007	Profit After Tax	7.564	8.035	14.154	2.462	1.359	3.584	2.755	1.733	0.720	6.561
	Total Income	3.844	5.852	6.803	2.510	1.428	3.445	3.280	1.537	0.872	3.080
	Total Export	2.179	8.071	12.912	1.334	0.746	4.207	4.972	0.300	0.015	0.137
2008	Profit After Tax	10.435	7.218	4.891	2.431	1.600	4.562	2.992	1.493	0.704	5.533
	Total Income	4.413	5.845	5.016	2.488	1.354	3.705	3.315	1.457	0.874	2.724
	Total Export	3.090	8.052	8.658	1.670	0.851	5.193	5.132	0.282	0.013	0.154
2009	Profit After Tax	18.091	11.107	8.020	3.802	2.670	5.962	1.838	2.228	0.899	8.244
	Total Income	4.650	6.077	5.215	2.310	1.372	3.424	3.419	1.428	0.827	2.340
	Total Export	2.517	8.483	8.947	1.990	1.021	4.894	5.403	0.309	0.014	0.183
2010	Profit After Tax	7.526	9.057	7.085	4.215	1.737	5.434	4.403	1.994	0.649	4.290
	Total Income	2.619	5.724	4.969	2.433	1.440	3.666	3.360	1.410	0.810	2.067
	Total Export	2.279	7.881	8.189	2.608	1.201	5.648	5.669	0.322	0.012	0.194
2011	Profit After Tax	9.754	6.770	6.298	4.303	2.050	5.710	4.186	2.280	0.430	3.973
	Total Income	2.759	5.306	4.857	2.486	1.484	3.725	3.505	1.471	0.883	1.925
	Total Export	2.073	7.775	8.493	2.801	1.337	5.836	6.238	0.351	0.017	0.146
2012	Profit After Tax	14.160	9.367	7.604	5.480	2.594	6.704	-0.355	3.546	1.004	3.589
	Total Income	2.961	4.809	4.575	2.287	1.476	3.632	2.928	1.427	1.014	1.764
	Total Export	2.660	6.715	8.803	2.468	1.380	5.516	5.318	0.310	0.011	0.066
2013	Profit After Tax	3.583	10.454	8.781	3.458	3.790	8.743	3.440	3.441	1.004	4.004
	Total Income	1.682	5.141	5.218	2.290	1.754	4.347	3.375	1.554	1.039	1.773
	Total Export	2.934	6.750	9.303	2.355	1.847	6.581	5.903	0.344	0.018	0.030
2014	Profit After Tax	-13.885	6.815	9.489	4.436	3.742	11.559	5.754	2.180	0.974	2.464
	Total Income	1.547	4.794	4.887	2.251	1.679	4.618	3.579	1.439	1.148	1.411
	Total Export	2.729	5.944	8.897	2.407	1.882	6.869	6.399	0.334	0.017	0.011

2015	Profit After Tax	-7.948	6.368	9.062	6.853	3.360	12.926	8.176	1.982	1.234	2.543
	Total Income	3.888	4.752	4.727	2.613	1.740	4.612	3.808	1.574	1.081	1.672
	Total Export	5.022	5.144	8.053	3.050	1.535	6.352	6.790	0.374	0.013	0.007
2016	Profit After Tax	-3.993	5.369	5.046	7.481	6.399	10.393	5.972	2.571	0.937	1.375
	Total Income	3.358	5.090	4.359	3.066	2.354	4.743	3.905	1.725	1.105	1.217
	Total Export	4.142	6.995	7.600	4.661	3.028	0.000	7.423	0.676	0.017	0.000
2017	Profit After Tax	-0.084	3.591	5.097	2.438	3.146	11.569	6.286	3.253	1.019	1.240
	Total Income	3.331	4.363	4.075	1.521	1.921	5.077	3.894	1.879	1.177	1.223
	Total Export	0.000	9.806	15.189	0.000	0.000	0.000	14.844	0.000	0.030	0.000
2018	Profit After Tax	1.045	5.022	1.939	3.730	1.648	4.598	6.199	2.448	1.372	1.204
	Total Income	3.746	4.290	3.504	2.196	1.673	3.730	3.782	1.960	1.248	1.081
	Total Export	0.000	11.914	0.000	0.000	0.000	0.000	19.270	0.000	0.057	0.000
2019	Profit After Tax	2.450	5.667	3.833	4.458	2.237	4.618	4.590	2.400	1.351	1.276
	Total Income	3.707	4.150	3.486	2.276	1.968	3.752	3.985	1.890	1.214	1.049
	Total Export	0.000	12.023	0.000	0.000	0.000	0.000	21.063	0.000	0.039	0.000
2020	Profit After Tax	7.315	5.281	6.692	3.219	2.138	1.657	4.276	2.880	1.351	0.251
	Total Income	4.481	3.982	3.695	2.261	1.880	3.378	4.037	2.051	1.241	1.129
	Total Export	0.000	11.285	0.000	0.000	0.000	0.000	21.911	0.000	0.024	0.000
2021	Profit After Tax	1.358	3.978	3.524	2.379	1.834	2.028	5.017	2.716	1.113	0.576
	Total Income	4.074	3.581	3.586	2.002	1.665	2.842	4.159	1.942	1.119	0.847
	Total Export	0.000	10.393	0.000	0.000	0.000	0.000	23.099	0.000	0.051	0.000
2022	Profit After Tax	-0.148	4.381	2.404	1.271	1.469	-0.280	2.155	2.283	1.183	2.504
	Total Income	3.701	3.580	3.255	1.785	1.519	2.624	2.618	2.038	1.097	1.068
	Total Export	0.000	8.744	0.000	0.000	0.000	0.000	11.158	0.000	0.054	0.000
2023	Profit After Tax	3.654	5.432	5.646	3.305	2.272	0.919	2.659	2.452	2.052	1.313
	Total Income	5.019	3.899	4.167	2.270	1.846	2.731	3.140	2.288	1.314	0.795
	Total Export	0.000	6.438	0.000	0.000	0.000	0.000	10.461	0.000	0.028	0.000

(Source: CMIE's, Prowess IQ and calculated by the researcher)

The table titled “Top 10 Pharmaceutical Companies of India by Market Capitalization (as of 1st April 2024) and their percentage share of Profits after tax,Total Income,Total export” shows the percentage share profits of the companies from 1992 to 2023. Percentage share of the total Profits after tax, Total Income, Total Exports respectively for each company for all the years mentioned, this data was sought from the CMIE- Prowess IQ database.

a. *Sun Pharmaceutical Inds. Ltd*: From humble beginnings in 1983,Sun Pharma has grown to become one of the largest generic pharmaceutical companies worldwide.It went public in 1994 and that partially explains the absence of data on the CMIE database.1992&1993 have no records mentioned and in the year 1994, Sun Pharma had a 1.272% share of the total profits after tax, it does seem like a small number but that is 74.4 million. They contributed a little over 0.6% & 0.23% that is 544.2 million and 25.2 million respectively. In the year 1997, Profit After Tax: 7.758% (Increase by 123.05% from 1996) ₹490.7 million, the total Income: 1.442% (Increase by 38.72% from 1996) ₹1976.1 million while the total Export: 0.336958246 (Increase by 31.84% from 1996) ₹87.1 million. Substantial growth across all financial metrics, especially profit after tax.1998 Profit After Tax: 14.619% (Increase by 88.77% from 1997) ₹545.5 million, the Total Income: 1.859% (Increase by 28.83% from 1997) ₹2909 million, Total Export: 1.139% (Increase significantly in total export) ₹357.2 million, Remarkable growth in profit after tax and total export, solid increase in total income. Continued growth in profit after tax and total export, stable total income. Year 2000 saw Significant decrease in profit after tax, moderate growth in total income, decrease in total export. With Profit After Tax: 7.327% (Decrease by 59.24% from 1999) ₹836.6 million, Total Income: 2.286% (Increase by 16.46% from 1999) ₹4926.3 million, Total Export: 1.287% (Decrease in total export) ₹552 million. In the year 2004 the profit After Tax: 7.246% (Decrease by 19.57% from 2003) ₹2406 million, Total Income:

2.638% (Increase by 5.28% from 2003) ₹10169 million, Total Export: 1.706% (Increase in total export) ₹2041.1 million. Significant decrease in profit after tax, moderate increase in total income and total export. Year 2007 saw Profit After Tax: 7.564% (Decrease by 18.70% from 2006) ₹6289.3 million, Total Income: 3.844% (Increase by 3.26% from 2006) ₹24723.9 million, Total Export: 2.178% (Decrease in total export) ₹4805.6 million. Decrease in profit after tax, moderate increase in total income, decrease in total export. Year 2008 drastic increase Profit After Tax: 10.434% (Increase by 38.92% from 2007) ₹10140.4 million, Total Income: 4.412% (Increase by 14.77% from 2007) ₹33434.4 million, Total Export: 3.089% (Increase in total export) ₹8064.5 million. Significant growth in profit after tax, total income, and total export. A few years saw negative profits, Year 2014 Profit After Tax: -13.884% (Significant decrease from 2013) ₹-28285.2 million, Total Income: 1.546% (Decrease from 2013) ₹31736.7 million, Total Export: 2.728% (Decrease in total export) ₹22713.3 million. Substantial decrease in profit after tax and total income. Year 2020 saw significant growth in profit after tax and total income, no change in total export, Profit After Tax: 7.315% (Increase from 2019) ₹32111.4 million, Total Income: 4.480% (Increase from 2019) ₹152721.4 million. .Year 2022, Profit After Tax: -0.1481% (Decrease from 2021) ₹-999.9 million, Total Income: 3.7013% (Decrease from 2021) ₹169292.8 million, Year 2023, Profit After Tax: 3.65% (Increase from 2022) ₹16907.2 million, Total Income: 5.0186% (Increase from 2022) ₹211414.3 million, Recovery in profit after tax and total income.

Summary

1. Sun Pharmaceutical Inds. Ltd. experienced fluctuating profit after tax, total income, and total export over the years.

2. Significant growth periods were observed in the late 1990s and early 2000s, followed by fluctuations and challenges in later years.
3. Recovery and improvement in financial metrics were seen in recent years (2020-2023) , indicating potential stability and growth.
4. Fluctuations in profit after tax and total income, along with changes in export figures, reflect market dynamics and operational challenges faced by the company during different periods.

b. *Cipla Ltd.:* Cipla Limited is an Indian multinational pharmaceutical company headquartered in Mumbai. Cipla primarily focuses on developing medication to treat respiratory disease, cardiovascular disease, arthritis, diabetes, depression, and various other medical conditions(*Cipla - Wikipedia*, n.d.) In the year 1992 the Profit After Tax: 5.028%, Total Income: 2.918%, and Total Export: 2.95%. Started with a healthy profit after tax, total income, and total export in 1992. However in the year 1995 the profit After Tax: 3.354% (Increase by 34.39% from 1994), Total Income: 2.746% (Decrease by 4.02% from 1994), Total Export: 1.950% (Decrease in total export).Recovery in profit after tax, slight decrease in total income, decrease in total export. Year 1998 the Profit After Tax: 27.329% (Significant increase from 1997), Total Income: 3.456% (Decrease from 1997) and the Total Export: 2.32% (Decrease in total export). Continued growth in profit after tax, slight decrease in total income and total export. Year 2000 saw Profit After Tax: 11.653% (Decrease from 1999), while Total Income: 3.672% (Increase from 1999) and Total Export: 3.280% (Decrease in total export). Decrease in profit after tax, increase in total income, decrease in total export. Year 2005 rose with Profit After Tax: 10.818% (Increase from 2004), Total Income: 5.929% (Increase from 2004) and Total Export: 7.8179% (Increase in total export). Recovery in profit after tax, significant growth in total income and total export. In the year 2011, Profit After Tax: 6.769% (Decrease from 2010), Total Income: 5.306% (Decrease from 2010) , Total Export: 7.775% (Decrease in

total export). There was a Decrease in profit after tax, total income, and total export. Year 2017, profit After Tax: 3.59% (Decrease from 2016), Total Income: 4.362% (Decrease from 2016), Total Export: 9.806% (Significant increase in total export) , Decrease in profit after tax and total income, significant increase in total export. Year 2023, the Profit After Tax: 5.431% (Increase from 2022), where the total Income: 3.899% (Increase from 2022), and the total Export: 6.438% (Decrease from 2022) growth in profit after tax and total income, decrease in total export.

Summary

1. Cipla Ltd. experienced fluctuations in profit after tax, total income, and total export over the years.
2. Significant growth periods were observed in the late 1990s and early 2000s, followed by fluctuations and challenges in later years.
3. Recovery and improvement in financial metrics were seen in recent years (2019-2023) , indicating potential stability and growth.
4. Fluctuations in profit after tax, total income, and total export reflect market dynamics and operational challenges faced by the company during different periods.

c. *Dr. Reddy's Laboratories Ltd.:* Dr. Reddy's Laboratories is an Indian multinational pharmaceutical company based in Hyderabad. The company was founded by Kallam Anji Reddy, who previously worked in the mentor institute Indian Drugs and Pharmaceuticals Limited. Dr. Reddy manufactures and markets a wide range of pharmaceuticals in India and overseas(“Dr. Reddy’s Laboratories,” 2024). In the beginning of this researches accounting period, Year 1992, the Profit After Tax: 6.258%, Total Income: 2.002%, Total Export: 2.622%. Dr. Reddy's started with a strong profit after tax, total income, and total export in 1992. The Year 1993, their profit After Tax: 7.63% (Increase by 21.94% from 1992), the Total Income: 2.049% (Increase by 2.37% from 1992), Total Export: 3.705% (Increase in total export). There

was Growth in profit after tax, slight increase in total income, significant increase in total export. Sudden change in the year 1994, where the Profit After Tax: 4.309% (Decrease by 43.55% from 1993), Total Income: 2.013% (Decrease by 1.77% from 1993), Total Export: 3.845% (Increase in total export), Decrease in profit after tax and total income, increase in total export. Year 1999 the profit After Tax: 15.775% (Increase by 20.39% from 1998), Total Income: 2.311% (Increase from 1998), Total Export: 3.395% (Decrease in total export) Continued growth in profit after tax, total income, decrease in total export. Year 2006, Profit After Tax: 4.260% (Increase from 2005) and Total Income: 4.630% (Increase from 2005) while the Total Export: 7.4269% (Increase in total export). Recovery in profit after tax, total income, and total export. Year 2012, Profit After Tax: 7.60% (Increase from 2011), Total Income: 4.57% (Decrease from 2011), Total Export: 8.803% (Increase in total export). The company saw Increase in profit after tax and total export, decrease in total income. Year 2018, Profit After Tax: 1.938% (Decrease from 2017), Total Income: 3.503% (Decrease from 2017),In Year 2019, Profit After Tax: 3.832% (Increase from 2018), Total Income: 3.486% (Increase from 2018). Year 2023, Profit After Tax: 5.646% (Increase from 2022), Total Income: 4.167% (Increase from 2022).

Summary

1. Dr. Reddy's Laboratories Ltd. experienced significant growth periods, especially in the late 1990s and early 2000s, followed by fluctuations and challenges in later years.
2. The company's performance in profit after tax, total income, and total export varied across different years, reflecting market dynamics and operational challenges.
3. The trend of growth, stability, and occasional decline in financial metrics underscores the importance of market conditions and business strategies on company performance over time.

d. *Zydus Lifesciences Ltd.:* Zydus Lifesciences Limited, formerly known as Cadila Healthcare Limited, is an Indian multinational pharmaceutical company headquartered in Ahmedabad, which is primarily engaged in the manufacture of generic drugs. The company ranked 100th in the Fortune India 500 list in 2020("Zydus Lifesciences," 2024). To begin with, in the Year 1996: the Profit After Tax: First reported profit of 0.40%, indicating the beginning of positive financial performance. Total Income: Initial total income reported at 1.65%. Total Export: First reported total export at 1.17%. 2001: saw Profit After Tax: Increase to 4.10%. Total Income: Slight increase to 2.13%. Total Export: Increase to 1.13%. Year 2005: took a turn with Profit After Tax: Decreasing to 3.47%. Total Income: Decrease to 2.89 %. Total Export: Decrease to 1.02%. 2011: Profit After Tax: Increase to 4.30%, Total Income: Slight increase to 2.49 %, Total Export: Increase to 2.80 %. 2012: Profit After Tax: Increase to 5.48 %. Total Income: Decrease to 2.29 %. Total Export: Decrease to 2.47%. 2018: Profit After Tax: Increase to 3.73 %, Total Income: Increase to 2.20 %, finally 2023: Profit After Tax: Increase to 3.30 %. Total Income: Increase to 2.27 %.

Summary

1. The company experienced fluctuations in profitability, total income, and total export over the years.
2. Profitability showed growth phases (e.g., 1998-1999, 2009-2011, 2015-2016) and decline phases (e.g., 2000-2001, 2002-2004, 2007-2008) .
3. Total income generally increased over the years but fluctuated with occasional decreases.
4. Total exports demonstrated a consistent upward trend, indicating expansion into international markets.

This detailed year-by-year interpretation provides insights into how Zydus Lifesciences Ltd.'s financial performance evolved over time, reflecting periods of growth, stability, and challenges.

e. *Torrent Pharmaceutical Ltd.*: Torrent Pharmaceuticals Ltd is an Indian multinational pharmaceutical company, part of the Torrent Group and headquartered in Ahmedabad("Torrent Pharmaceuticals," 2024). It was promoted by U. N. Mehta, initially as Trinity Laboratories Ltd, and was later renamed Torrent Pharmaceuticals Ltd. 1992, Profit After Tax: 2.02%, Total Income: 1.41%, from which in 1997: the Profit After Tax: Increase to 5.69% (+84%), Total Income: Increase to 2.62% (+4%), Total Export: Started reporting at 0.28%. 2002: Profit After Tax: Decrease to 2.31% (-11%) , Total Income: Increase to 1.89% (+11%) and Total Export: Decrease to 0.45 %. In 2007: Profit After Tax: Slight increase to 1.36 % (+2%), Total Income: Slight decrease to 1.43% (-4%), Total Export: Decrease to 0.75%. 2008:Profit After Tax: Increase to 1.60% (+18%), Total Income: Decrease to 1.35% (-6%), Total Export: Increase to 0.85%. The year 2013: Profit After Tax: Increase to 3.79 % (+46%), Total Income: Increase to 1.75 % (+18%), Total Export: Increase to 1.85 %. 2017: saw the profit After Tax: Decrease to 3.15 % (-51%), the total Income: Decrease to 1.92 % (-18%). In 2021: Profit After Tax: Decrease to 1.83 % (-14%), Total Income: Decrease to 1.66 % (-12%) and 2022:Profit After Tax: Decrease to 1.47 % (-20%) and Total Income: Decrease to 1.52 % (-8%). Finally 2023:Profit After Tax: Increase to 2.27 % (+55%) , Total Income: Increase to 1.85 % (+22%).

Summary

1. Torrent Pharmaceuticals Ltd. experienced varying trends in profitability, total income, and total export over the years.
2. Profitability showed significant fluctuations, with some years seeing substantial growth and others experiencing declines.
3. Total income demonstrated mixed trends, with periods of growth and decline.

f. *Lupin Ltd.:* Lupin Limited is an Indian multinational pharmaceutical company based in Mumbai(“Lupin Limited,” 2024). It is one of the largest generic pharmaceutical companies by revenue globally.The company's key focus areas include paediatrics, cardiovascular, anti-infectives, diabetology, asthma and anti-tuberculosis. 1995, Profit After Tax: Decrease to 0.24% (-83%) , Total Income: Slight increase to 0.55% (+6%), while 1999: Profit After Tax: Increase to 3.81% (+30%), Total Income: Decrease to 0.61% (-14%). In 2007: the profit After Tax: Slight decrease to 3.58% (-1%), Total Income: Slight increase to 3.44% (+0%) and Total Export: Decrease to 4.21%. 2012, Profit After Tax: Increase to 6.70 % (+17%), Total Income: Decrease to 3.63 % (-2%), Total Export: Decrease to 5.52 %. 2013:Profit After Tax: Increase to 8.74 % (+30%), whose Total Income: Increase to 4.35 % (+20%) and Total Export: Increase to 6.58 %, In the year 2019: their Profit After Tax: Slight increase to 4.62 % (+0.4%), Total Income: Slight increase to 3.75 % (+0.7%).

202 saw the Profit After Tax: Increase to 0.92 % (turnaround from loss), Total Income: Increase to 2.73 % (+4%).

Summary

1. Lupin Ltd. experienced varying trends in profitability, total income, and total export over the years.
2. Profitability showed significant fluctuations, with periods of growth, decline, and even a loss.
3. Total income demonstrated mixed trends, with some years seeing growth while others experienced declines.
4. Total export activities were limited initially but showed substantial growth in certain years before stabilizing or decreasing in later years.

g. *Aurobindo Pharma Ltd:* Aurobindo Pharma Limited is an Indian multinational pharmaceutical manufacturing company headquartered in HITEC City, Hyderabad, India. The

company manufactures generic pharmaceuticals and active pharmaceutical ingredients(“Aurobindo Pharma,” 2024). The year 1998:saw big changes with Profit After Tax: Increase to 6.38 % (+218%), Total Income: Increase to 1.90 % (+17%), Total Export: Decrease to 3.00 % (-14%) from the previous year. 2003: Profit After Tax: Increase to 4.02 % (+27%), Total Income: Decrease to 3.76 % (-5%), Total Export: Decrease to 5.93 % (-15%). 2009: Profit After Tax: Decrease to 1.84 % (-38%), Total Income: Increase to 3.42 % (+3%), Total Export: Increase to 5.40 % (+5%). The year 2014: Profit After Tax: Increase to 5.75 % (+67%), Total Income: Increase to 3.58 % (+6%), Total Export: Increase to 6.40 % (+8%). After the setting off of COVID 2020: Profit After Tax: Slight decrease to 4.28 % (-7%), Total Income: Slight increase to 4.04 % (+1%), Total Export: Slight increase to 21.91 % (+4%), soon in 2022: Profit After Tax: Decrease to 2.15 % (-57%), Total Income: Decrease to 2.62 % (-37%), Total Export: Decrease to 11.16 % (-52%). Finally 2023: profit After Tax: Increase to 2.66% (+24%), Total Income: Increase to 3.14 % (+20%), Total Export: Decrease to 10.46 % (-6%).

Summary

1. Aurobindo Pharma Ltd. experienced significant growth in profitability, total income, and total export during the late 1990s and early 2000s.
2. The company faced fluctuations in performance over the years, with periods of growth, stability, and occasional declines.
3. Notable increases in total export were observed in certain years, reflecting expanding international market presence.
4. Profitability and financial performance were subject to industry dynamics, regulatory changes, and market conditions, impacting the company's trajectory over time.

h. *Alkem Laboratories Ltd.:* Alkem Laboratories Limited is an Indian multinational pharmaceutical company headquartered in Mumbai, that manufactures and sells pharmaceutical generics, formulations and nutraceuticals in India and globally(“Alkem

Laboratories," 2024). Dawn of 1999: Profit After Tax: 3.19%, Total Income: 1.42 %, Total Export: 0.15 %. 2000: Profit After Tax: Decrease to 1.04 % (-67%), Total Income: Increase to 1.54 % (+8%), Total Export: Increase to 0.22 % (+47%). In 2004: the Profit After Tax: Increase to 2.62 %, Total Income: Decrease to 1.55 % (-4%), Total Export: Increase to 0.33 % (+50%). 2007: Profit After Tax: Decrease to 1.73 % (-39%), Total Income: Decrease to 1.54 % (-6%), Total Export: Slight increase to 0.30 % (+3%). In the year 2011: Profit After Tax: Increase to 2.28 % (+15%), Total Income: Increase to 1.47 % (+4%), Total Export: Increase to 0.35 % (+9%). Year 2015: had Profit After Tax: Decrease to 1.98 % (-9%), Total Income: Increase to 1.57 % (+9%), Total Export: Increase to 0.37 % (+13%). In 2018: the Profit After Tax: Decrease to 2.45 % (-25%), Total Income: Increase to 1.96 % (+4%). 2022:profit After Tax: Decrease to 2.28 % (-16%), Total Income: Increase to 2.04 % (+5%). Finally 2023: Profit After Tax: Increase to 2.45 % (+7%), Total Income: Increase to 2.29 % (+12%).

Summary

1. Alkem Laboratories Ltd. started reporting profits and growth from 1999 onwards.
2. The company experienced fluctuations in profitability, total income, and total export over the years, with periods of growth and decline.
3. Notable increases in total income and some decreases in profitability were observed in recent years.
4. The company's performance was subject to industry dynamics, regulatory changes, and market conditions, impacting its financial trajectory.

i. *Abbott India Ltd.:* Established in 1910, Abbott in India is one of the country's oldest and most admired healthcare companies. The company provide consumers with a diverse range of diagnostics solutions, medical devices, nutritional products and established pharmaceuticals that span the continuum of care("Abbott Laboratories," 2024).

The year 1992: Profit After Tax: 3.61 %, Total Income: 2.27 %, Total Export: 0.72 %. Skip to 1996: the Profit After Tax: Increase to 0.95 % (+12%), Total Income: Decrease to 1.61 % (-25%) and the total Export: Decrease to 0.004 % (-93%). 1999: profit After Tax: Decrease to 8.24 % (-38%), Total Income: Decrease to 1.65 % (-18%), Total Export: Decrease to 0.10 % (-70%)

In 2001, Profit After Tax: Decrease to 4.52 % (-25%), Total Income: Increase to 1.82 % (+5%), Total Export: Decrease to 0.06 % (-12%), 2004: Profit After Tax: Decrease to 2.08 % (-7%), Total Income: Decrease to 1.21 % (-12%) while the Total Export: Slight increase to 0.02 % (+6%). 2008: the Profit After Tax: Slight decrease to 0.70 % (-3%), Total Income: Slight increase to 0.87 % (+1%) and Total Export: Decrease to 0.01 % (-7%). 2012: Profit After Tax: Increase to 1.00 % (+133%), Total Income: Increase to 1.01 % (+15%), Total Export: Decrease to 0.01 % (-44%), 2016: Profit After Tax: Decrease to 0.94 % (-24%), Total Income: Increase to 1.11 % (+3%), Total Export: Increase to 0.02 % (+41%). 2020: Profit After Tax: Slight decrease to 1.35% (-0.04%), Total Income: Increase to 1.24% (+2%), Total Export: Decrease to 0.02% (-50%). 2022: Profit After Tax: Increase to 1.18 % (+6%) , Total Income: Decrease to 1.10 % (-6%), Total Export: Increase to 0.05 % (+3%), finally 2023: Profit After Tax: Increase to 2.05 % (+74%), Total Income: Increase to 1.31 % (+19%), Total Export: Decrease to 0.03 % (-40%).

Summary

1. Abbott India Ltd. showed significant fluctuations in Profit After Tax, Total Income, and Total Export over the years, influenced by market conditions, regulatory changes, and industry dynamics.
2. The company experienced periods of growth, stability, and decline in profitability and revenue streams.

3. Notable increases in profitability were observed in certain years, followed by fluctuations in subsequent periods.
4. Total exports showed varying trends, with some years experiencing growth and others declining.

Overall, Abbott India Ltd.'s financial performance reflects the challenges and opportunities in the pharmaceutical industry, with a mix of positive and negative growth indicators over the analyzed period.

j. *Glaxosmithkline Pharmaceuticals Ltd.:* GlaxoSmithKline Pharmaceuticals Ltd is an Indian research-based pharmaceutical and healthcare company, and a subsidiary of GSK. The company's product portfolio includes prescription medicines and vaccines(“GlaxoSmithKline Pharmaceuticals,” 2024). In the beginning of this research paper, 1992: the Profit After Tax: 3.01%, Total Income: 9.41%, and Total Export: 2.46 %. Which decreased in 1996: Profit After Tax: Decrease to 17.36 % (-20%), Total Income: Decrease to 8.69 % (-16%), Total Export: Decrease to 1.15 % (-29%). 1999: Profit After Tax: Increase to 26.41 % (+139%), Total Income: Decrease to 4.88 % (-3%), Total Export: Increase to 1.86 % (+31%), 2003: Profit After Tax: Increase to 3.82 % (+68%), Total Income: Decrease to 3.84 % (-18%), Total Export: Decrease to 0.61 % (-42%). In 2007:Profit After Tax: Decrease to 6.56 % (-35%), Total Income: Decrease to 3.08 % (-18%), Total Export: Decrease to 0.14 % (-17%). 2010: Profit After Tax: Decrease to 4.29 % (-48%), Total Income: Decrease to 2.07 % (-12%), Total Export: Slight increase to 0.19 % (+4%). 2014: Profit After Tax: Decrease to 2.46 % (-39%), Total Income: Decrease to 1.41 % (-20%), Total Export: Decrease to 0.01 % (-66%). Before the dawn of Covid, 2017: Profit After Tax: Decrease to 1.24 % (-10%), Total Income: Slight increase to 1.22% (-0.1%). In the year 2020: the Profit After Tax: Decrease to 0.25 % (-80%), Total Income: Increase to 1.13 % (+8%), and in the latest period 2023: Profit After Tax: Decrease to 1.31 % (-48%), Total Income: Decrease to 0.80 % (-25%).

Summary

1. Glaxosmithkline Pharmaceuticals Ltd. experienced significant fluctuations in Profit After Tax, Total Income, and Total Export over the years, affected by various factors including market conditions, regulatory changes, and industry dynamics.
2. The company saw periods of substantial growth, followed by declines in profitability and revenue streams.
3. Total exports remained stagnant in later years, reflecting potential shifts in international market strategies. Overall, Glaxosmithkline Pharmaceuticals Ltd.'s financial performance illustrates the challenges and adaptations required in the pharmaceutical sector, with varying growth trajectories and strategic considerations over the analyzed period.

4.2 INTERNATIONALIZATION AND GROWTH

This section attempts to analyze 4 variables (Pharmaceutical Exports, Pharmaceutical Sales, R&D Capital Expenditure and R&D Current Expenditure) that are very crucial to the growth of the Industry as well as the volume of the goods being exported. Primarily to get insights into whether the variables make a difference or lead to change in the other variable.

4.2.1 GRANGER CAUSALITY TEST 2 Year Lag

a. *Pharma Exports Does Not Granger Cause R&D Capital Expenditure*

Granger causality test

Model 1: R&D Cap = b0 + b1 R&D Capital Expenditure (t-1) + b2 R&D Capital Expenditure (t-2) + y1 Pharma Exports (t-1) +y2 Pharma Exports (t-2) + u

Model 2: R&D Cap = b0 + b1 R&D Cap (t-1) + b2 R&D Cap (t-2)+ u

Res.Df	Df	F	Pr(>F)	
1	25			
2	27	-2	10.251	0.0005607 ***

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Model 1 includes lagged values of both "R&D Capital Expenditure" and "Pharma Exports."

Model 2 includes only lagged values of "R&D Capital Expenditure."

The results indicate that:

1. Model 1 has a residual degrees of freedom (Res.Df) of 25, suggesting 25 observations after accounting for the model's parameters.
2. Model 2 has a residual degrees of freedom (Res.Df) of 27, suggesting 27 observations after accounting for the model's parameters.
3. The F-statistic for Model 1 is 10.251.
4. The p-value associated with Model 1 is very small (0.0005607), indicating statistical significance.
5. The test is performed with a significance level of 0.05.

The interpretation of these results is as follows:

1. Model 1 tests whether adding lagged values of "Pharma Exports" improves the prediction of "R&D Capital Expenditure" compared to Model 2, which only includes lagged values of "R&D Capital Expenditure" itself.
2. The small p-value (<0.05) associated with Model 1 indicates that including lagged values of "Pharma Exports" significantly improves the prediction of "R&D Capital Expenditure."
3. Therefore, based on this analysis, there is evidence to suggest that "Pharma Exports" Granger-causes "R&D Capital Expenditure" at the 0.05 significance level.

b. R&D Capital Expenditure Does Not Granger Cause Pharma Exports

Granger causality test
Model 1: Pharma Exports = b0 + b1 Pharma Exports (t-1) + Pharma Exports (t-2) + y1 R&D Cap(t-1) + y2 R&D Cap (t-2) + u
Model 2: Pharma Exports = b0 + b1 Pharma Exports (t-1) + b2 Pharma Exports (t-2) + u
  Res.Df Df F Pr(>F)
1 25
2 27 -2 4.4843 0.02167 *

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Model 1 includes lagged values of both "Pharma Exports" and "R&D Capital Expenditure."

Model 2 includes only lagged values of "Pharma Exports."

The results indicate that:

1. Model 1 has a residual degrees of freedom (Res.Df) of 25, suggesting 25 observations after accounting for the model's parameters.
2. Model 2 has a residual degrees of freedom (Res.Df) of 27, suggesting 27 observations after accounting for the model's parameters.
3. The F-statistic for Model 1 is 4.4843.
4. The p-value associated with Model 1 is 0.02167, indicating statistical significance.
5. The test is performed with a significance level of 0.05.

The interpretation based on these results is:

1. Model 1 tests whether adding lagged values of "R&D Capital Expenditure" improves the prediction of "Pharma Exports" compared to Model 2, which only includes lagged values of "Pharma Exports" itself.
2. The small p-value (<0.05) associated with Model 1 indicates that including lagged values of "R&D Capital Expenditure" significantly improves the prediction of "Pharma Exports."

3. Therefore, based on this analysis, there is evidence to suggest that "R&D Capital Expenditure" Granger-causes "Pharma Exports" at the 0.05 significance level.

c. Pharma Exports Does Not Granger Cause R&D Current Expenditure

```
Granger causality test
Model 1: R&D Cur  = b0 + b1 R&D Cur (t-1) + b2 R&D Cure (t-2) + y1 Pharma Exports (t-1)
+ y2 Pharma Exports (t-2) + u
Model 2: R&D Cur  = b0 + b1 R&D Cur (t-1) + R&D Cur (t-2) + u
  Res.Df Df      F    Pr(>F)
1     25
2     27 -2 13.518 0.0001048 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Model 1 includes lagged values of both "R&D Current Expenditure" and "Pharma Exports."

Model 2 includes only lagged values of "R&D Current Expenditure."

The results indicate that:

1. Model 1 has a residual degrees of freedom (Res.Df) of 25, suggesting 25 observations after accounting for the model's parameters.
2. Model 2 has a residual degrees of freedom (Res.Df) of 27, suggesting 27 observations after accounting for the model's parameters.
3. The F-statistic for Model 1 is 13.518.
4. The p-value associated with Model 1 is very small (0.0001048), indicating statistical significance.
5. The test is performed with a significance level of 0.05.

The interpretation parallels that of the previous analysis:

1. Model 1 tests whether adding lagged values of "Pharma Exports" improves the prediction of "R&D Current Expenditure" compared to Model 2, which only includes lagged values of "R&D Current Expenditure" itself.
2. The small p-value (<0.05) associated with Model 1 indicates that including lagged values of "Pharma Exports" significantly improves the prediction of "R&D Current Expenditure."
3. Therefore, based on this analysis, there is evidence to suggest that "Pharma Exports" Granger-causes "R&D Current Expenditure" at the 0.05 significance level.

d. *R&D Current Expenditure Does Not Granger Cause Pharma Exports*

Granger causality test
Model 1: Pharma Exports = b0 + b1 Pharma Exports (t-1) + b2 Pharma Exports (t-2) + y1 R&D Cur (t-1) + y2 R&D Cur (t-2)+ u
Model 2: Pharma Exports = b0 + b1 Pharma Exports (t-1) + b2 Pharma Exports (t-2)+ u

	Res.Df	Df	F	Pr(>F)
1	25			
2	27	-2	0.9748	0.3911

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Model 1 includes lagged values of both "Pharma Exports" and "R&D Current Expenditure."

Model 2 includes only lagged values of "Pharma Exports."

The results indicate that:

1. Model 1 has a residual degrees of freedom (Res.Df) of 25, suggesting 25 observations after accounting for the model's parameters.
2. Model 2 has a residual degrees of freedom (Res.Df) of 27, suggesting 27 observations after accounting for the model's parameters.
3. The F-statistic for Model 1 is 0.9748.
4. The p-value associated with Model 1 is 0.3911, indicating no statistical significance.

5. The test is performed with a significance level of 0.05.

The interpretation based on these results is:

1. Model 1 tests whether adding lagged values of "R&D Current Expenditure" improves the prediction of "Pharma Exports" compared to Model 2, which only includes lagged values of "Pharma Exports" itself.
2. The relatively large p-value (0.3911) associated with Model 1 indicates that including lagged values of "R&D Current Expenditure" does not significantly improve the prediction of "Pharma Exports."
3. Therefore, based on this analysis, there is no evidence to suggest that "R&D Current Expenditure" Granger-causes "Pharma Exports" at the 0.05 significance level.

e. *R&D Capital Expenditure Does Not Granger Cause R&D Current Expenditure*

```
Granger causality test
Model 1: R&D Cur = b0 + b1 R&D Cur (t-1) + b2 R&D Cur (t-2) + y1 R&D Cap (t-1) + y2
R&D Cap (t-2) + u
Model 2: R&D Current Expenditure = b0 + b1 R&D Cur (t-1) + b2 R&D Cur (t-2) + u
  Res.Df Df      F  Pr(>F)
1     25
2     27 -2 4.8967 0.01605 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Model 1 includes lagged values of both "R&D Current Expenditure" and "R&D Capital Expenditure."

Model 2 includes only lagged values of "R&D Current Expenditure."

The results indicate that:

1. Model 1 has a residual degrees of freedom (Res.Df) of 25, suggesting 25 observations after accounting for the model's parameters.

2. Model 2 has a residual degrees of freedom (Res.Df) of 27, suggesting 27 observations after accounting for the model's parameters.
3. The F-statistic for Model 1 is 4.8967.
4. The p-value associated with Model 1 is 0.01605, indicating statistical significance.
5. The test is performed with a significance level of 0.05

The interpretation based on these results is:

Model 1 tests whether adding lagged values of "R&D Capital Expenditure" improves the prediction of "R&D Current Expenditure" compared to Model 2, which only includes lagged values of "R&D Current Expenditure" itself.

1. The small p-value (<0.05) associated with Model 1 indicates that including lagged values of "R&D Capital Expenditure" significantly improves the prediction of "R&D Current Expenditure."
2. Therefore, based on this analysis, there is evidence to suggest that "R&D Capital Expenditure" Granger-causes "R&D Current Expenditure" at the 0.05 significance level.

f. *R&D Current Expenditure Does Not Granger Cause R&D Capital Expenditure*

```
Granger causality test
Model 1: R&D Cap = b0 + b1 R&D Cap (t-1) + b2 R&D Cap (t-2) + y1 R&D Cur (t-1) + y2
R&D Cur (t-2) + u
Model 2: R&D Cap = b0 + b1 R&D Cap (t-1) + b2 R&D Cap (t-2)+ u
  Res.Df Df     F  Pr(>F)
1     25
2     27 -2 3.278 0.05442 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Model 1 includes lagged values of both "R&D Capital Expenditure" and "R&D Current Expenditure."

Model 2 includes only lagged values of "R&D Capital Expenditure."

The results indicate that:

1. Model 1 has a residual degrees of freedom (Res.Df) of 25, suggesting 25 observations after accounting for the model's parameters.
2. Model 2 has a residual degrees of freedom (Res.Df) of 27, suggesting 27 observations after accounting for the model's parameters.
3. The F-statistic for Model 1 is 3.278.
4. The p-value associated with Model 1 is 0.05442, indicating a lack of statistical significance at the typical 0.05 significance level.
5. The test is performed with a significance level of 0.05.

The interpretation based on these results is:

1. Model 1 tests whether adding lagged values of "R&D Current Expenditure" improves the prediction of "R&D Capital Expenditure" compared to Model 2, which only includes lagged values of "R&D Capital Expenditure" itself.
2. The p-value (0.05442) associated with Model 1 is greater than 0.05, suggesting that the improvement in prediction achieved by adding lagged values of "R&D Current Expenditure" is not statistically significant.
3. Therefore, based on this analysis, there is no strong evidence to suggest that "R&D Current Expenditure" Granger-causes "R&D Capital Expenditure" at the 0.05 significance level.

Table 4.3 Summary of All the Values From the Pairwise Granger Causality Test With 2 Year Lag Models.

Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Prob.
R&D Capital Expenditure does not Granger Cause Pharma Exports	25	10.251	0.0005607
Pharma Exports does not Granger Cause R&D Capital Expenditure		4.4843	0.02167
R&D Current Expenditure does not Granger Cause Pharma Exports	25	13.518	0.0001048
Pharma Exports does not Granger Cause R&D Current Expenditure		0.9748	3.91E-01
R&D Current Expenditure does not Granger Cause R&D Capital Expenditure	25	4.8967	0.01605
R&D Capital Expenditure does not Granger Cause R&D Current Expenditure		3.278	0.05442

g. *Summary:* The Pairwise Granger Causality Test with 2 year lag model helps analyze the cause and effect relationship. The lagged models are very crucial to the variables picked as all of them need context about the past figures, a variable and its figure taken for one year gives no context but if the past values are provided it helps predict or find estimates a lot better.

There is evidence to support the claim that Pharmaceutical Exports Granger Causes R&D Capital expenditure. In short, the evidence suggests that strong performance in exporting pharmaceutical products (Pharmaceutical Exports) leads to increased investment in research and development (R&D Capital Expenditure) by pharmaceutical companies a couple of years later. Granger Causality: Past success in exporting pharmaceuticals (a cause) is statistically linked to future increases in R&D spending (an effect). Lag: There's likely a time delay (a couple of years) between the export success and the R&D investment increase. This makes sense because developing new drugs and getting them to market takes time. Similarly an increase in R&D Capital expenditure leads to a strong performance of Pharmaceutical Exports

because of reasons like better quality products or better packaging or more effective products. Pharmaceutical Exports also in turn lead to an investment in R&D Current Expenditure, naturally if there's extra income coming in the company may choose to invest in its workforce or raw materials. On the other hand there is no evidence really to support the claim that R&D Current Expenditure Granger causes Exports even with the lagged value, similarly in the case of capital Expenditure, R&D current expenditure does not necessarily Granger Causes R&D Capital Expenditure, but R&D Capital Expenditure Granger Causes R&D Current Expenditure, naturally, Increased investment in Capital Expenditure will set the ball rolling on exports which inturn increase the investment on R&D Current Expenditure.

4.2.2 Granger Causality Test 3 Year Lag

a. R&D Current Expenditure Does Not Granger Cause R&D Capital Expenditure

Granger causality test
Model 1: R&D Cap = b0 + b1 R&D Cap (t-1) + b2 R&D Cap (t-3) + y1 R&D Cur (t-1) + y2 R&D Cur (t-3) + u
Model 2: R&D Capital Expenditure = b0 + b1 R&D Cap (t-1) + b2 R&D Cap (t-3)+ u
  Res.Df Df   F Pr(>F)
1   22
2   25 -3 2.9665 0.05419 .

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Model 1 includes lagged values of both "R&D Capital Expenditure" and "R&D Current Expenditure" up to lag 3.

Model 2 includes only lagged values of "R&D Capital Expenditure" up to lag 3.

The results indicate that:

1. Model 1 has a residual degrees of freedom (Res.Df) of 22, suggesting 22 observations after accounting for the model's parameters.
2. Model 2 has a residual degrees of freedom (Res.Df) of 25, suggesting 25 observations after accounting for the model's parameters.

3. The F-statistic for Model 1 is 2.9665.
4. The p-value associated with Model 1 is 0.05419, indicating a lack of statistical significance at the typical 0.05 significance level.
5. The test is performed with a significance level of 0.05.

The interpretation based on these results is:

1. Model 1 tests whether adding lagged values of "R&D Current Expenditure" improves the prediction of "R&D Capital Expenditure" compared to Model 2, which only includes lagged values of "R&D Capital Expenditure" itself.
2. The p-value (0.05419) associated with Model 1 is slightly greater than 0.05, suggesting that the improvement in prediction achieved by adding lagged values of "R&D Current Expenditure" is not statistically significant.
3. Therefore, based on this analysis, there is no strong evidence to suggest that "R&D Current Expenditure" Granger-causes "R&D Capital Expenditure" at the 0.05 significance level

b. *R&D Capital Expenditure Does Not Granger Cause R&D Current Expenditure*

Granger causality test
Model 1: R&D Cur = b0 + b1 R&D Cur (t-1) + b2 R&D Cur (t-3) + y1 R&D Cap (t-1) + y2 R&D Cap (t-3) + u
Model 2: R&D Current Expenditure = b0 + b1 R&D Cur (t-1) + b2 R&D Cur (t-3) + u
  Res.Df Df   F Pr(>F)
1   22
2   25 -3 4.7693 0.01041 *

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Model 1 includes lagged values of both "R&D Current Expenditure" and "R&D Capital Expenditure" up to lag 3.

Model 2 includes only lagged values of "R&D Current Expenditure" up to lag 3.

The results indicate that:

1. Model 1 has a residual degrees of freedom (Res.Df) of 22, suggesting 22 observations after accounting for the model's parameters.
2. Model 2 has a residual degrees of freedom (Res.Df) of 25, suggesting 25 observations after accounting for the model's parameters.
3. The F-statistic for Model 1 is 4.7693.
4. The p-value associated with Model 1 is 0.01041, indicating statistical significance at the 0.05 significance level.
5. The test is performed with a significance level of 0.05.

The interpretation based on these results is:

1. Model 1 tests whether adding lagged values of "R&D Capital Expenditure" improves the prediction of "R&D Current Expenditure" compared to Model 2, which only includes lagged values of "R&D Current Expenditure" itself.
2. The small p-value (0.01041) associated with Model 1 indicates that including lagged values of "R&D Capital Expenditure" significantly improves the prediction of "R&D Current Expenditure."
3. Therefore, based on this analysis, there is evidence to suggest that "R&D Capital Expenditure" Granger-causes "R&D Current Expenditure" at the 0.05 significance level.

c. *R&D Current Expenditure Does Not Granger Cause Pharma Exports*

Granger causality test
Model 1: Pharma Exports = b0 + b1 Pharma Exports (t-1) + b2 Pharma Exports (t-3) + y1 R&D Cur (t-1) + y2 R&D Cur (t-3)+ u
Model 2: Pharma Exports = b0 + b1 Pharma Exports (t-1) + b2 Pharma Exports (t-3)+ u

	Res.Df	Df	F	Pr(>F)
1	22			
2	25	-3	0.8585	0.4772

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Model 1 includes lagged values of both "Pharma Exports" and "R&D Current Expenditure" up to lag 3.

Model 2 includes only lagged values of "Pharma Exports" up to lag 3.

The results indicate that:

1. Model 1 has a residual degrees of freedom (Res.Df) of 22, suggesting 22 observations after accounting for the model's parameters.
2. Model 2 has a residual degrees of freedom (Res.Df) of 25, suggesting 25 observations after accounting for the model's parameters.
3. The F-statistic for Model 1 is 0.8585.
4. The p-value associated with Model 1 is 0.4772, indicating no statistical significance.
5. The test is performed with a significance level of 0.05.

The interpretation based on these results is:

1. Model 1 tests whether adding lagged values of "R&D Current Expenditure" improves the prediction of "Pharma Exports" compared to Model 2, which only includes lagged values of "Pharma Exports" itself.

2. The p-value (0.4772) associated with Model 1 is greater than 0.05, suggesting that the improvement in prediction achieved by adding lagged values of "R&D Current Expenditure" is not statistically significant.
3. Therefore, based on this analysis, there is no evidence to suggest that "R&D Current Expenditure" Granger-causes "Pharma Exports" at the 0.05 significance level.

d. *Pharma Exports Does Not Granger Cause R&D Current Expenditure*

Granger causality test
Model 1: R&D Current Expenditure = b0 + b1 R&D Cur (t-1) + b2 R&D Cure (t-3) + y1 Pharma Exports (t-1) + y2 Pharma Exports (t-3) + u
Model 2: R&D Current Expenditure = b0 + b1 R&D Cur (t-1) + R&D Cur (t-3) + u
  Res.Df Df   F   Pr(>F)
1   22
2   25 -3 11.582 9.237e-05 ***

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Model 1 includes lagged values of both "R&D Current Expenditure" and "Pharma Exports" up to lag 3.

Model 2 includes only lagged values of "R&D Current Expenditure" up to lag 3.

The results indicate that:

1. Model 1 has a residual degrees of freedom (Res.Df) of 22, suggesting 22 observations after accounting for the model's parameters.
2. Model 2 has a residual degrees of freedom (Res.Df) of 25, suggesting 25 observations after accounting for the model's parameters.
3. The F-statistic for Model 1 is 11.582.
4. The p-value associated with Model 1 is very small (9.237e-05), indicating statistical significance.

5. The test is performed with a significance level of 0.05.

The interpretation based on these results is:

1. Model 1 tests whether adding lagged values of "Pharma Exports" improves the prediction of "R&D Current Expenditure" compared to Model 2, which only includes lagged values of "R&D Current Expenditure" itself.
2. The very small p-value (9.237e-05) associated with Model 1 indicates that including lagged values of "Pharma Exports" significantly improves the prediction of "R&D Current Expenditure."
3. Therefore, based on this analysis, there is evidence to suggest that "Pharma Exports" Granger-causes "R&D Current Expenditure" at the 0.05 significance level.

e. *R&D Capital Expenditure Does Not Granger Cause Pharma Exports*

Granger causality test
Model 1: Pharma Exports = b0 + b1 Pharma Exports (t-1) + Pharma Exports (t-3) + y1 R&D Cap(t-1) + y2 R&D Cap (t-3) + u
Model 2: Pharma Exports = b0 + b1 Pharma Exports (t-1) + b2 Pharma Exports (t-3) + u
  Res.Df Df F Pr(>F)
1 22
2 25 -3 8.929 0.0004643 ***

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Model 1 includes lagged values of both "Pharma Exports" and "R&D Capital Expenditure" up to lag 3.

Model 2 includes only lagged values of "Pharma Exports" up to lag 3.

The results indicate that:

1. Model 1 has a residual degrees of freedom (Res.Df) of 22, suggesting 22 observations after accounting for the model's parameters.

2. Model 2 has a residual degrees of freedom (Res.Df) of 25, suggesting 25 observations after accounting for the model's parameters.
3. The F-statistic for Model 1 is 8.929.
4. The p-value associated with Model 1 is very small (0.0004643), indicating statistical significance.
5. The test is performed with a significance level of 0.05.

The interpretation based on these results is:

1. Model 1 tests whether adding lagged values of "R&D Capital Expenditure" improves the prediction of "Pharma Exports" compared to Model 2, which only includes lagged values of "Pharma Exports" itself.
2. The small p-value (0.0004643) associated with Model 1 indicates that including lagged values of "R&D Capital Expenditure" significantly improves the prediction of "Pharma Exports."
3. Therefore, based on this analysis, there is evidence to suggest that "R&D Capital Expenditure" Granger-causes "Pharma Exports" at the 0.05 significance level.

f. *Pharma Exports Does Not Granger Cause R&D Capital Expenditure*

Granger causality test

Model 1: R&D Cap = b0 + b1 R&D Capital Expenditure (t-1) + b2 R&D Capital Expenditure (t-3) + y1 Pharma Exports (t-1) +y2 Pharma Exports (t-3) + u

Model 2: R&D Cap = b0 + b1 R&D Cap (t-1) + b2 R&D Cap (t-3)+ u

```
Res.Df Df      F  Pr(>F)
1     22
2     25 -3 5.5616 0.00538 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Model 1 includes lagged values of both "R&D Capital Expenditure" and "Pharma Exports" up to lag 3.

Model 2 includes only lagged values of "R&D Capital Expenditure" up to lag 3.

The results indicate that:

1. Model 1 has a residual degrees of freedom (Res.Df) of 22, suggesting 22 observations after accounting for the model's parameters.
2. Model 2 has a residual degrees of freedom (Res.Df) of 25, suggesting 25 observations after accounting for the model's parameters.
3. The F-statistic for Model 1 is 5.5616.
4. The p-value associated with Model 1 is 0.00538, indicating statistical significance.
5. The test is performed with a significance level of 0.05.

The interpretation based on these results is:

1. Model 1 tests whether adding lagged values of "Pharma Exports" improves the prediction of "R&D Capital Expenditure" compared to Model 2, which only includes lagged values of "R&D Capital Expenditure" itself.
2. The small p-value (0.00538) associated with Model 1 indicates that including lagged values of "Pharma Exports" significantly improves the prediction of "R&D Capital Expenditure."
3. Therefore, based on this analysis, there is evidence to suggest that "Pharma Exports" Granger-causes "R&D Capital Expenditure" at the 0.05 significance level.

Table 4.4 Summary of all the values from the Pairwise Granger Causality Test with 3-year lag models.

Lags: 3			
Null Hypothesis:	Obs	F-Statistic	Prob.
R&D Capital Expenditure does not Granger Cause R&D Current Expenditure	22	2.9665	0.05419
R&D Current Expenditure does not Granger Cause R&D Capital Expenditure		4.7693	0.01041
Pharma Exports does not Granger Cause R&D Current Expenditure	22	0.8585	0.4772
R&D Current Expenditure does not Granger Cause Pharma Exports		11.582	9.24E-05
Pharma Exports does not Granger Cause R&D Capital Expenditure	22	8.929	0.0004643
R&D Capital Expenditure does not Granger Cause Pharma Exports		5.5616	0.00538

g. *Summary:* The Granger Causality Test, when used with a three-year lag, can shed light on how variables might influence each other over time. This time lag is important because it gives the analysis more background. Imagine trying to understand someone's mood based on just one day's information - it wouldn't tell the whole story. By looking at past data points (like the past two - three years), the test can make more accurate predictions or estimates about how one variable might affect another.

Lag 2 and Lag 3 models show similar results when it comes to the final statements. There is no strong evidence to suggest that R&D Current Expenditure Grancer Causes R&D Capital Expenditure and also R&D Current Expenditure does’nt Granger Cause Pharma Exports. So Investments in R&D Current Expenditure will not lead to an impact in the Capital Expenditure nor Exports but it does have some positive effects that are discussed below in the VAR model. Meanwhile Granger Causality 3 year lag model continues to show that investments in R&D Capital Expenditure will lead to a positive impact on R&D Current

expenditure and Increased value of Exports. Pharmaceutical Exports too when faced with an increase spillover the benefits over to R&D Current Expenditure as well as R&D Capital Expenditure with the benefit being investments.

4.2.3 Var Model

a. Vector Autoregression Estimates

Sample (adjusted): 1993 2023

Included observations: 31 after adjustments

Standard errors in ( ) & t-statistics in [ ]

	Pharma Exports	R&D Capital Expenditure	R&D Current Expenditure
Pharma Exports (-1)	0.820052	0.006757	0.022332
	(0.10805)	(0.00243)	(0.00335)
	[7.58940]	[2.78099]	[6.67520]
R&D Capital Expenditure (-1)	7.649559	0.535427	-0.359849
	(7.49039)	(0.16843)	(0.23192)
	[1.02125]	[3.17887]	[-1.55162]

R&D Current Expenditure (-1)	-5.953232	-0.088603	0.627361
	(2.23493)	(0.05026)	(0.06920)
	[-2.66372]	[-1.76304]	[9.06620]
C	-16480.28	127.6723	-1359.558
	(32482.0)	(730.406)	(1005.71)
	[-0.50737]	[0.17480]	[-1.35184]
Pharma Sales	0.248672	0.004450	0.015116
	(0.08236)	(0.00185)	(0.00255)
	[3.01949]	[2.40282]	[5.92798]
R-squared	0.919583	0.902526	0.997825
Adj. R-squared	0.907211	0.887530	0.997490
Sum sq. resids	2.12E+11	1.07E+08	2.04E+08
S.E. equation	90391.71	2032.595	2798.707
F-statistic	74.32889	60.18440	2981.488

Log likelihood	-395.0299	-277.3899	-287.3051
Akaike AIC	25.80838	18.21870	18.85839
Schwarz SC	26.03967	18.44999	19.08968
Mean dependent	328187.5	7456.674	50790.82
S.D. dependent	296743.5	6060.833	55861.96

Determinant resid covariance (dof adj.)	8.66E+22
Determinant resid covariance	5.11E+22
Log likelihood	-942.4297
Akaike information criterion	61.76966
Schwarz criterion	62.46352
Number of coefficients	15

Note: Here Pharma Sales is an exogenous variable. Lag of exogenous variable is 1

b. VAR Model:

VAR Model:

==========

PHARMA_EXPORTS = C(1,1)*PHARMA_EXPORTS(-1) + C(1,2)*R_D_CAPITAL_EXPENDITURE(-1) + C(1,3)*R_D_CURRENT_EXPENDITURE(-1) + C(1,4) + C(1,5)*PHARMA_SALES

R_D_CAPITAL_EXPENDITURE = C(2,1)*PHARMA_EXPORTS(-1) + C(2,2)*R_D_CAPITAL_EXPENDITURE(-1) + C(2,3)*R_D_CURRENT_EXPENDITURE(-1) + C(2,4) + C(2, 5)*PHARMA_SALES

R_D_CURRENT_EXPENDITURE = C(3,1)*PHARMA_EXPORTS(-1) + C(3,2)*R_D_CAPITAL_EXPENDITURE(-1) + C(3,3)*R_D_CURRENT_EXPENDITURE(-1) + C(3,4) + C(3,5)*PHARMA_SALES

VAR Model - Substituted Coefficients:

==========

PHARMA_EXPORTS = 0.820052327256*PHARMA_EXPORTS(-1) + 7.6495592889*R_D_CAPITAL_EXPENDITURE(-1) - 5.95323181859*R_D_CURRENT_EXPENDITURE(-1) - 16480.2782321 + 0.24867234458*PHARMA_SALES

R_D_CAPITAL_EXPENDITURE = 0.00675701650574*PHARMA_EXPORTS(-1) + 0.535426640517*R_D_CAPITAL_EXPENDITURE(-1) - 0.0886030442866*R_D_CURRENT_EXPENDITURE__RUP EES_MILLION_(-1) + 127.672254555 + 0.00444977213444*PHARMA_SALES

R_D_CURRENT_EXPENDITURE = 0.0223319591866*PHARMA_EXPORTS(-1) - 0.359848803197*R_D_CAPITAL_EXPENDITURE(-1) + 0.627361278625*R_D_CURRENT_EXPENDITURE__RUPE ES_MILLION_(-1) - 1359.55774905 + 0.0151157630294*PHARMA_SALES

Pharma Exports are influenced by a combination of factors, including its own past performance, R&D Capital Expenditure, R&D Current Expenditure, and a constant term.

Interpretation of The Var Model(s)

Pharmaceutical Exports

1. *High Positive Coefficient of PHARMA_EXPORTS(-1):* (0.820052) This indicates a strong positive relationship between Pharma Exports in the previous period (t-1) and current Pharma Exports (t). In other words, there is inertia in Pharma Exports, meaning strong past performance tends to lead to continued strong performance.
2. *Positive Coefficient of R_D_CAPITAL_EXPENDITURE(-1):* (7.649559) This suggests a positive influence of past R&D Capital Expenditure on current Pharma Exports. Increased investment in R&D Capital (e.g., new facilities or equipment) in the previous period might lead to higher exports in the current period, potentially due to development of new drugs or improved production efficiency.
3. *Negative Coefficient of R_D_CURRENT_EXPENDITURE(-1):* (-5.953232) This coefficient is negative, indicating a counter-intuitive relationship. It suggests that higher R&D Current Expenditure in the previous period might be associated with lower Pharma Exports in the current period. However, it's important to consider:

The high R-squared (0.9196) suggests the model explains a good portion of the variation in Pharma Exports. However, the high S.E. Equation (90391.71) indicates there is still some variability that the model doesn't capture. It is important to keep in mind that other things are kept constant like the model doesn't account for potential external factors that might influence Pharma Exports, such as global economic conditions or currency exchange rates.

Overall, this model suggests that past performance, R&D capital investment, and potentially R&D current expenditure all play a role in determining Pharma Exports.

R&D Capital Expenditure

R&D Capital Expenditure is primarily influenced by its own past value and to a lesser extent by Pharma Exports and Pharma Sales.

1. *High Positive Coefficient of R_D_CAPITAL_EXPENDITURE(-1):* (0.535427) This indicates a strong positive relationship between R&D Capital Expenditure in the previous period (t-1) and current expenditure (t). In other words, there is inertia in R&D Capital Expenditure, meaning past levels of investment tend to be followed by similar levels of investment in the current period.
2. *Weak Positive Coefficient of PHARMA_EXPORTS(-1):* (0.006757) This suggests a weak positive influence of past Pharma Exports on current R&D Capital Expenditure. Higher Pharma Exports in the previous period might lead to slightly increased investment in R&D capital in the current period, potentially for expanding production capacity or developing new products.
3. *Weak Positive Coefficient of PHARMA_SALES:* (0.004449) This coefficient is also positive but weak, indicating a possible connection between higher Pharma Sales and increased R&D Capital Expenditure. This could be due to companies using strong sales performance as a justification for investing in R&D to maintain a competitive edge.

The R-squared (0.9025) suggests the model explains a good portion of the variation in R&D Capital Expenditure. The S.E. Equation (2032.595) is lower compared to the Pharma Exports model, indicating a potentially better fit. Similar to the previous model, there might be external factors not included in the model that could influence R&D Capital Expenditure, such as government grants or technological advancements.

Overall, this model highlights the importance of past R&D Capital Expenditure and, to a lesser extent, Pharma Exports and Sales in determining current R&D Capital Expenditur

R&D Current Expenditure

R&D Current Expenditure is heavily influenced by its own past value, with some minor influence from Pharma Exports and a weak negative influence from R&D Capital Expenditure.

1. *Very Strong Positive Coefficient of R_D_CURRENT_EXPENDITURE(-1):* (0.627361) This is the dominant factor in the model. The exceptionally high positive coefficient indicates a strong inertia effect. In other words, current R&D expenditure is heavily dependent on the level of expenditure in the previous period. This suggests that R&D budgets tend to be relatively stable over time.
2. *Weak Positive Coefficient of PHARMA_EXPORTS(-1):* (0.022332) This suggests a weak positive influence of past Pharma Exports on current R&D Current Expenditure. Higher Pharma Exports in the previous period might lead to a slight increase in current R&D spending, possibly for ongoing research or development efforts.
3. *Weak Negative Coefficient of R_D_CAPITAL_EXPENDITURE(-1):* (-0.359849) This coefficient is negative, indicating a potentially counter-intuitive relationship. It suggests that higher R&D Capital Expenditure in the previous period might be associated with slightly lower current R&D expenditure. However, it's important to consider, The possibility of this coefficient being statistically insignificant.

The R-squared (0.9978) is exceptionally high, indicating the model explains a very large portion of the variation in R&D Current Expenditure. The S.E. Equation (2798.707) is also the lowest compared to the other two models, suggesting a very good fit. Similar to the previous models, there might be external factors not included in the model that could influence R&D Current Expenditure, such as scientific breakthroughs or changes in research priorities.

Overall, this model suggests that R&D Current Expenditure is primarily driven by its own past value, with some minor influence from Pharma Exports and a possible negative influence from R&D Capital Expenditure (depending on significance). The high inertia in R&D

Current Expenditure suggests that past spending patterns have a strong hold on current budget allocations.

The S.E. Equation, also known as the Standard Error of the Equation, reflects the average error between the actual values of your dependent variable and the values predicted by the model.

Lower S.E. Equation indicates a better fit: In your models,

PHARMA_EXPORTS: S.E. Equation = 90391.71

R_D_CAPITAL_EXPENDITURE: S.E. Equation = 2032.595

R_D_CURRENT_EXPENDITURE: S.E. Equation = 2798.707

R_D_CURRENT_EXPENDITURE has the lowest S.E. Equation (2798.707), signifying a very close fit between the predicted and actual values.

R_D_CAPITAL_EXPENDITURE has a moderately low S.E. Equation (2032.595), indicating a decent fit.

PHARMA_EXPORTS has the highest S.E. Equation (90391.71), suggesting the model's predictions for Pharma Exports have a larger average error compared to the other two equations.

High S.D. Dependent: This indicates a large variation in the actual values of the dependent variable. In your case:

PHARMA_EXPORTS: S.D. Dependent = 296743.5

R_D_CAPITAL_EXPENDITURE: S.D. Dependent = 6060.833

R_D_CURRENT_EXPENDITURE: S.D. Dependent = 55861.96

Pharma Exports has the highest standard deviation, suggesting a wider range of values compared to the other two variables.

Low S.D. Dependent: This signifies the actual values of the dependent variable are clustered closer to the mean, with less variation.

Interpretation In The Context Of The Model(S)

The high S.D. Dependent for Pharma Exports indicates that the model, despite a good R-squared, might not perfectly capture all the factors influencing exports. The reason behind such high S.D dependent values is due to the nature of the data, the raw data captures the exports in Rupees Million from 1992-2023 and the values were ₹5997.1 million and ₹731396.3 million respectively, whose difference if sought is ₹7,25,399.2 million, such a huge increase in exports over the years is bound to cause distortion in the estimates and lead to high S.D values. The lower S.D. Dependent values for R&D expenditures suggest the model might be better at explaining the factors influencing these variables compared to Pharma Exports.

c. Var Lag Order Selection Criteria

Endogenous variables:PHARMA_EXPORTS - R_D_CAPITAL

Exogenous variables: C - PHARMA_SALES

Sample: 1992 2023

Included observations: 31

Lag	LogL	LR	FPE	AIC	SC	H
0	-1021.38	NA	1.23E+25	66.28223	66.55978	66.3727
1	-942.43	132.4237*	1.36e+23*	61.76966*	62.46352*	61.99584*

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

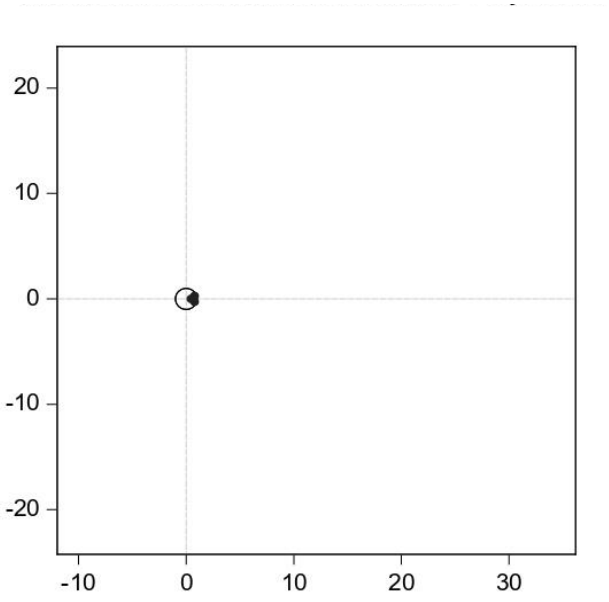
The asterisk (*) next to "1" in the LR, FPE, AIC and HQ columns Suggests that a lag order of 1 is preferred according to these four criteria.

d. Inverse Roots Of AR Characteristic Polynomial

Inverse Roots of AR Characteristic Polynomial

The AR (Autoregressive) characteristic polynomial is a mathematical equation used in time series analysis to analyze the stability of a model. The roots of this polynomial are important because they determine whether the model is stationary or not.

Figure 4.1. Inverse Roots of AR Characteristic Polynomial



The inverse roots of the characteristic polynomial are plotted on the complex plane (which combines the real and imaginary number axes). If all the inverse roots lie inside the unit circle (the shaded area in the image), then the model is considered stationary. Conversely, if any of the inverse roots fall outside the unit circle, the model is non-stationary.

e. *Var Residual Tests*

In Vector Autoregression (VAR) models, used to analyze relationships between multiple time series, VAR Residual Tests play a crucial role in assessing the model's validity. These tests evaluate the model's residuals, which are the leftover differences between the actual data and the model's predictions.

VAR Residual Serial Correlation LM Tests

Sample: 1992 2023

Included observations: 31

Null hypothesis: No serial correlation at lag h

Lag	LM stat	Prob
1	19.96184	0.0185
2	34.38439	0.0001
3	22.69764	0.0071

Probs from chi-square with 9 df.

Therefore, when there's no serial correlation, the errors in one period are independent of the errors in other periods.

VAR Residual Normality Tests

Orthogonalization: Cholesky (Lutkepohl)

Null Hypothesis: Residuals are multivariate normal

Sample: 1992 2023

Included observations: 31

Component	Jarque-Bera	df	Prob
1	128.1087	2	0.00
2	0.334242	2	0.8461
3	1.956164	2	0.376
Joint	130.3991	6	0.00

The Jarque-Bera test results likely show that the residuals for at least one component (equation) in your VAR model are not multivariate normal. This is because the null hypothesis of normality is likely rejected for at least one component based on the p-value.

VAR Residual Heteroskedasticity Tests (Levels and Squares)

Sample: 1992 2023

Included observations: 31

Joint test:

Chi-sq	df	Prob.
110.0202	48	0.000

The table shows the results of two tests for heteroskedasticity:

1. Levels: This test examines whether the variance of the residuals is related to the levels of the independent variables in the model.
2. Squares: This test examines whether the variance of the residuals is related to the squares of the independent variables in the model.

A low p-value (typically below 0.05) signifies a rejection of the null hypothesis, suggesting evidence of heteroskedasticity.

f. *Var Granger Causality/Block Exogeneity Wald Tests*

Sample: 1992 2023

Included observations: 31

Dependent variable: Pharma_exports

Excluded	Chi-sq	df	Prob.
R_D_CAPITAL_EXPE	1.04295	1	0.3071
R_D_CURRENT_EXP	7.095424	1	0.0077
All	7.882274	2	0.0194

Since the p-value (0.3071) is greater than the typical significance level of 0.05, we fail to reject the null hypothesis. There's not enough evidence to conclude that R_D_CAPITAL_EXPE Granger causes PHARMA_EXPORTS at the 5% significance level.

The p-value (0.0077) is much lower than 0.05. This suggests we reject the null hypothesis. There is evidence to conclude that R_D_CURRENT_EXP Granger causes PHARMA_EXPORTS at the 5% significance level. In other words, past values of R&D Current Expenditure seem to have a statistically significant influence on current Pharmaceutical Exports, after accounting for the effects of other variables included in the model.

The p-value (0.0194) is less than 0.05. This suggests we reject the null hypothesis. There is evidence to conclude that at least one of the excluded variables (R_D_CAPITAL_EXPE or R_D_CURRENT_EXP or both) Granger causes PHARMA_EXPORTS. However, this test doesn't tell you which specific variable is significant.

4.25.2 Overall Interpretation

Based on the individual tests, R&D Current Expenditure seems to Granger cause Pharmaceutical Exports, while the evidence for R&D Capital Expenditure is inconclusive. The joint test on all excluded variables confirms that at least one of them has a statistically significant influence on PHARMA_EXPORTS.

DEPENDENT VARIABLE: R_D_CAPITAL_EXPENDITURE

Excluded	Chi-sq	df	Prob.
PHARMA_EXPORTS	7.733885	1	0.0054
R_D_CURRENT_EXP	3.108319	1	0.0779
All	14.77246	2	0.0006

PHARMA_EXPORTS: The p-value (0.0054) is less than 0.05, so we reject the null hypothesis. This suggests pharmaceutical exports likely Granger cause R&D capital expenditure.

R_D_CURRENT_EXP: The p-value (0.0779) is higher than 0.05. We fail to reject the null hypothesis. There's not enough evidence to conclude that R&D current expenditure Granger causes R&D capital expenditure at the chosen significance level.

ALL: The p-value (0.0006) is very low, so we reject the null hypothesis. This suggests that at least one of the excluded variables (pharmaceutical exports or R&D current expenditure, or both) Granger causes R&D capital expenditure.

Overall

The results suggest that pharmaceutical exports likely Granger cause R&D capital expenditure, but the evidence for R&D current expenditure is inconclusive. There's definitely a Granger causality relationship from at least one of the excluded variables.

DEPENDENT VARIABLE: R_D_CURRENT_EXPENDITURE

Excluded	Chi-sq	df	Prob.
PHARMA_EXPORTS	44.55827	1	0.0000
R_D_CAPITAL_EXPE	2.407538	1	0.1208
All	48.74301	2	0.0000

PHARMA_EXPORTS: The p-value (0.0000) is very low, so we reject the null hypothesis. This suggests pharmaceutical exports likely Granger cause R&D current expenditure.

R_D_CAPITAL_EXP: The p-value (0.1208) is higher than 0.05. We fail to reject the null hypothesis. There's not enough evidence to conclude that R&D capital expenditure Granger causes R&D current expenditure at the chosen significance level.

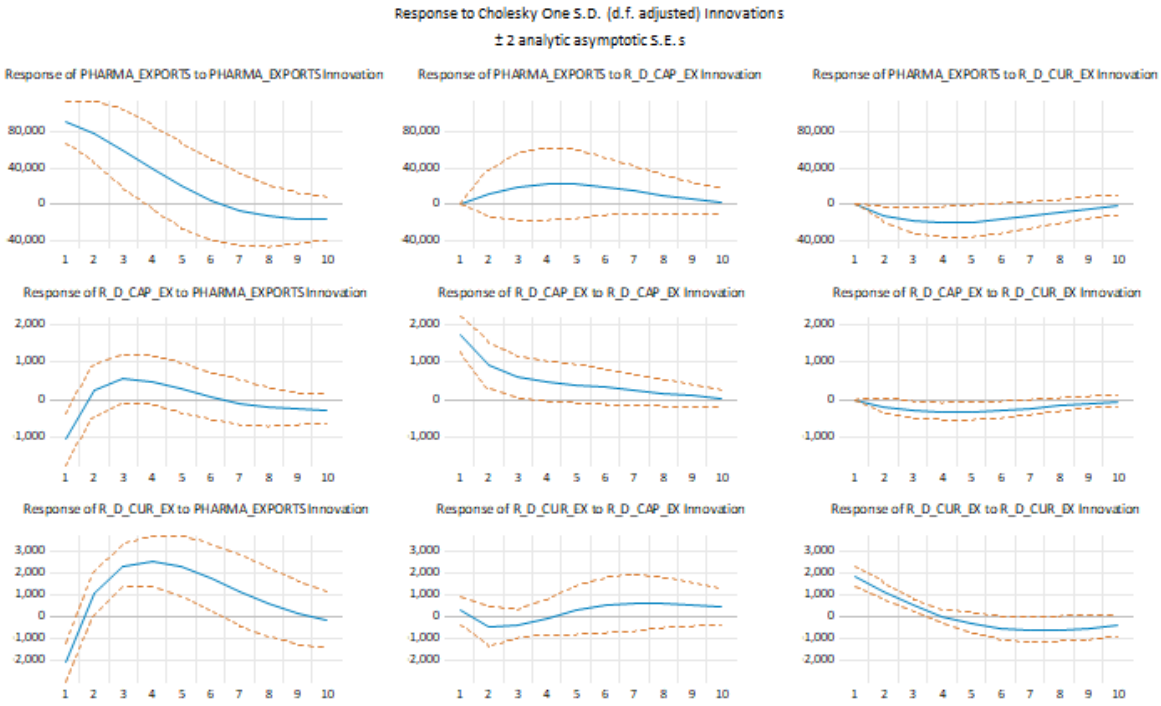
Overall

The results suggest that pharmaceutical exports likely Granger cause R&D current expenditure.

g. *Impulse Response Test*

The figure below shows the shock and response of the variables, Pharma Exports, R&D Capital Expenditure, R&D Current Expenditure with each other, all in all there are 9 graphs.

Figure 4.2 . Response to Cholesky One S.D. (d.f. adjusted) Innovations ± 2 Analytic Asymptotics S.E.s



The figures above show multiple graphs, each representing the response of a variable to a shock in another variable. The horizontal axis (X-axis) typically represents time periods following the shock. The vertical axis (Y-axis) represents the magnitude of the response. The lines on the graphs likely show how the variable on the Y-axis responds to a shock in the variable on the X-axis over time. The magnitude and direction of the line movements reflect the strength and direction of the impact.

1. Response of Pharma Exports to Pharma Exports Innovation

The response of Pharma Exports to a shock to Pharma Exports itself is positive and persistent. This means that a shock to Pharma Exports will cause Pharma Exports to increase, and this increase will persist for several periods.

2. Response of Pharma Exports to R&D Capital Expenditure Innovation

The response of Pharma Exports to R&D Capital Expenditure is slow rising positive and when it reaches its peak it slowly starts decreasing and then stays persistent for a while, but it remains positive throughout.

3. Response of Pharma Exports to R&D Current Expenditure Innovation

The response of Pharma Exports to R&D Current Expenditure is not a positive one, at initial stages it is negative but gradually starts rising at a slow pace, but eventually it does get positive.

4. Response of R&D Capital Expenditure to Pharma Exports Innovation

The response of R&D Capital Expenditure to a shock to Pharma Exports is positive and persistent. This means that a shock to Pharma Exports will cause R&D Capital Expenditure to increase, and this increase will persist for several periods.

5. Response of R&D Capital Expenditure to R&D Capital Expenditure Innovation

The response of R&D Capital Expenditure to a shock to R&D Capital Expenditure itself is positive and persistent. This means that a shock to R&D Capital Expenditure will cause R&D Capital Expenditure to increase, and this increase will persist for several periods.

6. Response of R&D Capital Expenditure to R&D Current Expenditure Innovation

The response of R&D Capital Expenditure to R&D Current Expenditure is not a positive one, at initial stages it is negative but gradually starts rising at a slow pace, but eventually it does get positive.

7. Response of Current Expenditure to Pharma Exports Innovation

The response of R&D Current Expenditure to a shock to Pharma Exports is positive and persistent. This means that a shock to Pharma Exports will cause R&D Current Expenditure, and this increase will persist for several periods.

8. Response of Current Expenditure to R&D Capital Expenditure Innovation

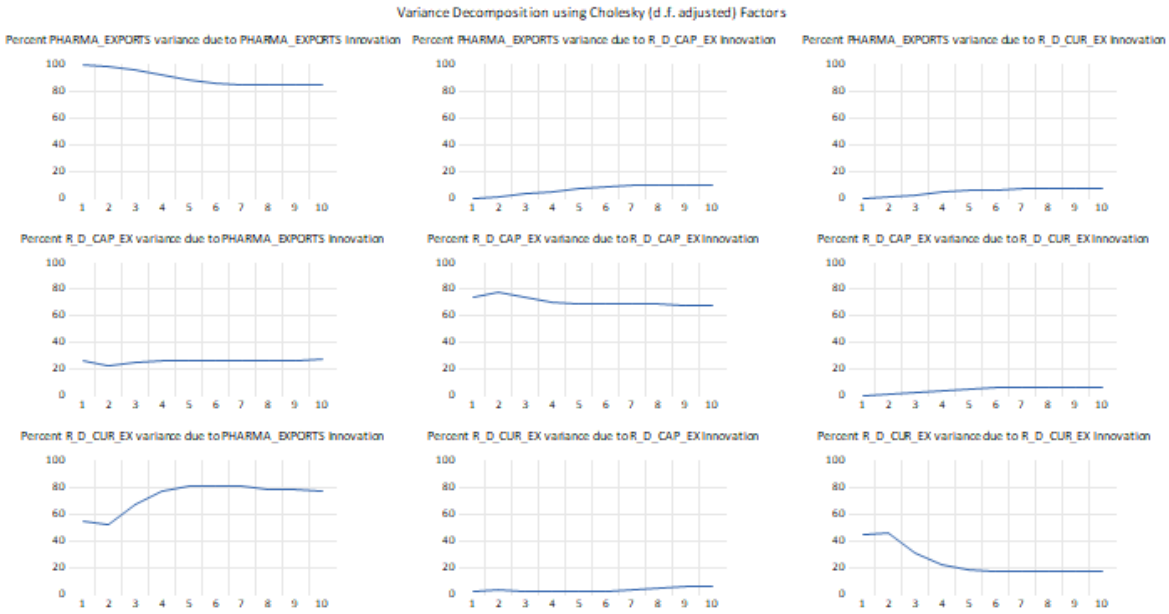
The response fluctuates, it starts positively but suddenly dips just above axis but it then achieves its positive peak, it stays positive throughout.

9. Response of Current Expenditure to R&D Current Expenditure Innovation

The response of R&D Current Expenditure to a shock to R&D Current Expenditure itself is positive and persistent. This means that a shock to R&D Current Expenditure will cause R&D Current Expenditure to increase, and this increase will persist for several periods.

h. *Variance Decomposition Test*

Figure 4.3. Variance Decomposition Using Cholesky (d.f. adjusted) Factors



The specific variance decomposition test used in the image is called Cholesky decomposition. It is a mathematical technique used to decompose the variance of a vector of

random variables into the sum of the variances of the innovations (unexplained errors) of the variables in the system.

1. Pharma Export Variance Due to Pharma Export Innovation

The line starts at 100% on the y-axis and trends downward to about 20% on the x-axis. This suggests that a high percentage of the variance in pharma exports can be explained by pharma exports innovation. In other words, changes in pharma exports innovation seem to be a major factor influencing how much pharma is being exported.

2. Pharma Export Variance Due to R&D Capital Expenditure Innovation

The line begins at 0% and rises slowly to not more than 20% and then remains constant, this may suggest that a low percentage of the variance in pharma exports is explained by R&D capital Expenditure.

3. Pharma Export Variance Due to R&D Current Expenditure Innovation

Similar to the above scenario the line starts at 0% and does not exceed 20%, this is evidence that very little variance in pharma Exports can be explained by R&D current expenditure

4. R&D Capital Expenditure Variance Due to Pharma Export Innovation.
    a) High initial impact: At the beginning of the forecast horizon (period 0), innovations in pharmaceutical exports explain a significant portion of the variance in R&D capital expenditures (around 30%).
    b) Decreasing impact over time: The impact of pharmaceutical export innovations on the variance of R&D capital expenditures weakens as we move into the future forecast horizon.
5. R&D Capital Expenditure Variance Due to R&D Capital Expenditure Innovation.
    a) High Initial Impact: At the beginning of the forecast horizon (period 0), innovations in R&D current expenditures explain a significant portion of the

variance in itself (a little above 70% at period 0). This suggests that the main driver of variation in R&D current expenditures in the short term is its own innovative activity.

b) Decreasing Impact Over Time: The impact of R&D current expenditure innovations on its own variance weakens as the forecast horizon progresses. This is because past innovations have a diminishing effect on future expenditures.

6. R&D Capital Expenditure Variance Due to R&D Current Expenditure Innovation
    a) High Initial Impact*:* At the beginning of the forecast horizon (period 0), innovations in R&D current expenditures explain a very low portion of the variance in itself (less than 10% at period 0). This suggests that the variation in R&D current expenditures in the short term plays a small role in its own innovative activity.
    b) Decreasing Impact Over Time: The impact of R&D current expenditure innovations on its own variance weakens as the forecast horizon progresses. This is because past innovations have a diminishing effect on future expenditures.
7. R&D Current Expenditure Variance Due to Pharma Export Innovation
    a) Very High Impact: At the beginning of the forecast horizon (period 0), innovations in R&D current expenditures have a significant impact on the variance of pharmaceutical exports (a little below 60% at period 0).
    b) Impact Rises drastically throughout the forecast: As the forecast horizon progresses, the impact of R&D current expenditure innovations on the variance of pharmaceutical exports remains very huge, but slows down eventually.
8. R&D Current Expenditure Variance Due to R&D Current Expenditure Innovation

R&D capital expenditures variance has very low impact on R&D current expenditure, at the initial stages it's very close to 0% but rises slowly and by period 10 it is better than 0% but still doesn't exceed 20%.

9. R&D Current Expenditure Variance Due to R&D Capital Expenditure Innovation

Before the 3rd period, R&D current expenditures innovation had a significant impact on itself, a little below 60% which explains the need to invest in innovation to gain later. The variance then gradually decreases and rests a little below 20% where it stays constant.

4.3 FOREIGN SHARE AND COMPETITIVENESS

This section of the analysis deals with the Indian Pharmaceutical Industry in the global market, laying emphasis primarily on the Exports and the share.

4.3.1 Percentage Share of India's Pharmaceutical Exports in India's Total Exports

Table 4.5. Percentage Share of India's Pharmaceutical Exports in India's Total Exports and Percentage Share of India’s Pharmaceutical Exports in World Pharmaceutical Exports

Year	Share of pharmaceutical in total Indian exports (%)	Share of India in world pharmaceutical exports (%)
1992	1.864255402	1.58963787
1993	1.919985749	1.417238281
1994	1.912284772	1.16132278
1995	1.914227818	1.065433055
1996	2.011519914	1.078927292
1997	2.248487071	1.139732096
1998	2.20330664	0.923926845

1999	2.332311745	0.971926455
2000	2.089621143	0.986117846
2001	2.386461673	0.908142451
2002	2.513152071	0.859985443
2003	2.637272195	0.873609288
2004	2.514414381	0.866851465
2005	2.335359925	0.960096922
2006	2.467928042	1.063966016
2007	2.626576278	1.089679929
2008	2.751193967	1.249232301
2009	2.834020028	1.177928977
2010	2.764510468	1.59623099
2011	2.735192904	1.991294064
2012	3.30481363	2.302523064
2013	3.462799067	2.709868126
2014	3.639758515	2.53779192
2015	4.726337104	2.832695731
2016	5.004347266	2.821567077
2017	4.37576432	2.579661491

2018	4.432869222	2.63042205
2019	5.029656643	2.832492304
2020	6.686576992	2.909297294
2021	4.926937585	2.524556341
2022	4.371335923	2.574808658

(Source: Word Integrated Trade Solutions, WITS. Ratio calculated by the researcher)

Interpretation Of India’s Percentage Share Of Pharmaceutical Expots Of The Total Exports

a. *Overall Trend Analysis*

The data shows a gradual increase in the share of pharmaceutical exports in India's total exports over the years. The percentage share has risen from around 1.86% in 1992 to over 4% consistently since 2014, with a significant jump to 6.69% in 2020.

b. *Key Observations*

1. Early Years (1992-2000): The share remains relatively low and stable, ranging between 1.86% and 2.33%. There is a slight increase during this period, reflecting modest growth in pharmaceutical exports.
2. Mid to Late 2000s (2001-2010): There is a noticeable increase starting from around 2001, reaching 2.76% by 2010. This decade shows a more substantial growth trajectory, possibly driven by increased global demand for Indian pharmaceutical products.

3. Recent Years (2011-2022): The share continues to rise significantly from 2011 onwards, surpassing 4% consistently after 2014. Notable peaks are observed in 2020 (6.69%) and a subsequent decline in 2021 (4.93%) and 2022 (4.37%).

c. *Factors Influencing Growth*

1. Global Demand and Competitiveness: India has emerged as a major player in the global pharmaceutical market, driven by competitive pricing and a strong manufacturing base. Increasing demand for generic drugs and active pharmaceutical ingredients (APIs) has boosted exports.
2. Policy and Regulatory Changes: Favorable government policies promoting pharmaceutical exports, such as incentives for export-oriented units (EOUs) and simplified regulatory procedures, have contributed to growth.
3. R&D and Innovation:Investments in research and development (R&D), coupled with a focus on innovation, have enhanced India's capability to produce high-quality pharmaceuticals for global markets.
4. Impact of Recent Events: The peak in 2020 (6.69%) could be attributed to various factors, including heightened global demand for pharmaceuticals during the COVID-19 pandemic. The subsequent decline in 2021 and 2022 might reflect normalization post-pandemic and evolving market dynamics.

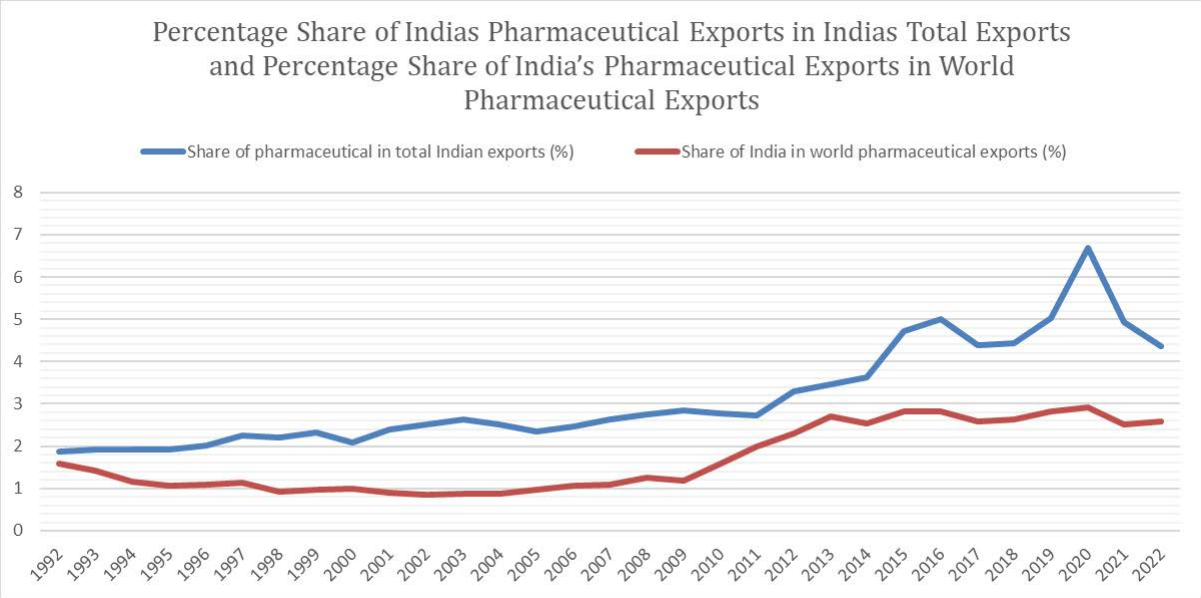
d. *Future Outlook*

The pharmaceutical sector is likely to remain a significant contributor to India's export revenue, driven by continued investments, technological advancements, and expansion into new markets. Diversification into specialized pharmaceutical products and increased focus on research-driven innovations could further propel export growth.

In summary, the data highlights a positive growth trend in the share of India's pharmaceutical exports over the past three decades, with notable expansion in recent years.

Understanding the underlying factors driving this growth is crucial for assessing future opportunities and challenges in the pharmaceutical export landscape.

Figure 4.4. Percentage Share of India's Pharmaceutical Exports in India's Total Exports and Percentage Share of India's Pharmaceutical Exports in World Pharmaceutical Exports



4.3.2 Percentage Share of India's Pharmaceutical Exports in World Pharmaceutical Exports

Interpretation Of India's Percentage Share Of Pharmaceutical Exports Of The Global Total Pharmaceutical Exports

a. *Overall Trend Analysis*

The data shows fluctuations in India's share of world pharmaceutical exports over the years.

There is an overall increasing trend, particularly from the mid-2000s onwards, with some variations in between.

b. *Key Observations*

1. Early Years (1992-2000): India's share started around 1.58% in 1992 and fluctuates within a relatively lower range (around 1% to 1.5%) during this period. There was a

decline in the late 1990s, possibly reflecting challenges or changes in the global pharmaceutical market.

2. Mid to Late 2000s (2001-2010): The share remains relatively stable but starts showing an upward trend around the mid-2000s.

Notable growth is observed from 2010 onwards, reaching around 1.99% in 2011.

3. Recent Years (2011-2022): India's share continues to increase steadily, surpassing 2% consistently after 2012. Peak share is observed in 2020 (2.91%), followed by some fluctuations in subsequent years.

c. *Factors Influencing Growth*

1. Rise of Indian Pharmaceutical Industry: India has emerged as a major player in the global pharmaceutical market, driven by a robust generic drugs industry and competitive pricing.
2. Increasing investments in research and development (R&D) and manufacturing capabilities have contributed to the growth in exports.
3. Quality and Cost Competitiveness: Indian pharmaceutical companies are known for producing high-quality drugs at competitive prices, which has boosted their global market share.
4. Global Demand and Supply Chain Dynamics: Growing demand for affordable healthcare solutions globally, coupled with evolving supply chain dynamics, has favored Indian pharmaceutical exports.
5. Impact of Recent Events: The COVID-19 pandemic may have influenced fluctuations in export shares, reflecting changing global market conditions and disruptions in supply chains.

d. *Future Outlook*

India's pharmaceutical export industry is expected to continue growing, driven by sustained investments, innovation, and expanding market reach. Diversification into new markets, increased focus on specialty drugs and biotechnology, and adherence to stringent quality standards will be key to maintaining and enhancing India's share in world pharmaceutical exports.

In summary, the data indicates a positive trajectory in India's share of world pharmaceutical exports over the years, highlighting the country's growing significance in the global pharmaceutical landscape. Understanding the underlying factors driving this growth is essential for formulating strategies to capitalize on emerging opportunities and navigate potential challenges in the industry.

4.3.3 Indian Pharma Export-Import Ratio Of Pharma Products

Table 4.6 Indian Pharma Export-Import Ratio of Pharma Products

Year	**Export/Import Ratio**
1992	4.317183153
1993	6.678653176
1994	7.24566841
1995	5.800351649
1996	10.45161391
1997	6.357492086
1998	5.379028284
1999	6.179391469

2000	5.908435266
2001	6.3927167
2002	5.787877832
2003	6.751402307
2004	6.594756214
2005	6.190739667
2006	5.404481876
2007	5.477628303
2008	5.551415769
2009	4.649985867
2010	4.989003775
2011	5.595058274
2012	5.460354493
2013	7.008743674
2014	7.107193479
2015	7.751966665
2016	7.698805423
2017	7.145931305
2018	5.758770758

2019	6.452560997
2020	7.457555829
2021	5.914217714
2022	7.233323653

(Source: Word Integrated Trade Solutions, WITS. Ratio calculated by the researcher)

Figure 4.5 Graphical Representation of the Export/Import Ratios:

To provide an overall trend analysis of India's Export/Import Ratio of pharmaceutical products from 1992 to 2022, we will examine the general direction of the ratio over the years and identify any notable patterns or changes in trade dynamics.

a. *General Trend*

The Export/Import Ratio fluctuated over the years, showing periods of increase, decrease, and relative stability. Overall, there was an upward trend in the ratio from the early 1990s to the mid-1990s, followed by fluctuations and varying levels throughout subsequent years.

b. *Key Observations*

1. 1990s to Early 2000s: The ratio experienced significant fluctuations during this period, with notable peaks and dips. There was a general trend of increasing export dominance in the pharmaceutical trade during the mid-1990s, followed by a mixed pattern in the late 1990s and early 2000s.
2. Mid-2000s to 2010s: The ratio showed relative stability with some fluctuations around the mid-2000s. There was a noticeable decrease in the ratio towards the late 2000s, possibly influenced by global economic conditions.
3. 2010s to 2020s*:*The ratio exhibited recovery and growth post-2010, with a significant increase observed in the early 2010s. From around 2013 to 2022, the ratio generally trended upwards, indicating a strengthening export position in the pharmaceutical sector.
4. Peak Years: The years 1996, 2013, 2014, and 2020 stand out as peak years with relatively high Export/Import Ratios, indicating strong export dominance in those periods. These peak years could be influenced by factors such as increased global demand for Indian pharmaceuticals, policy changes, or economic conditions.

c. *Positive Ratio*

With the exception of a few years, the Export/Import Ratio has been positive throughout the period. This indicates that India has generally exported more pharmaceutical products than it has imported. A rising Export/Import Ratio suggests a growing share of Indian pharmaceutical products in the global market. A more favorable ratio indicates improved trade balance and competitiveness in the pharmaceutical sector.

d. *Future Outlook*

Continued efforts to enhance export competitiveness, invest in research and development, strengthen manufacturing capabilities, and diversify product offerings will be

key to sustaining and further increasing India's Export/Import Ratio in the pharmaceutical industry. Monitoring global market trends, adapting to regulatory changes, and leveraging emerging technologies will also play a crucial role in shaping India's pharmaceutical trade dynamics.

In conclusion, India's Export/Import Ratio of pharmaceutical products has shown a mix of fluctuations and overall growth over the years, reflecting the evolving landscape of the global pharmaceutical market and India's position therein. Understanding the underlying factors driving these trends is essential for formulating strategic initiatives to capitalize on opportunities and address challenges in the pharmaceutical trade sector.

4.3.4 Representation of Region Wise Distribution Of India’s Pharma Exports During 2022-23

Table 4.7 Region-wise distribution of India’s Pharma exports during 2022-23

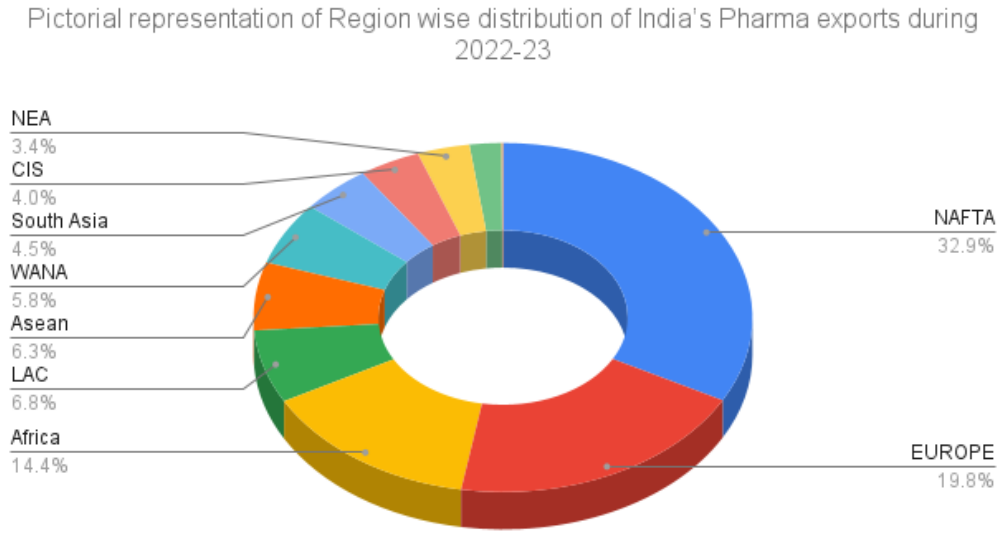
India's Pharma exports Region wise $ Mn						
Region	Fy-21	Fy-22	Change %	Fy-23	Change %	Contbn %
NAFTA	8392.84	7814.61	-6.89	8347.24	6.82	32.87
EUROPE	4234.59	4432.06	4.66	5032.4	13.55	19.82
Africa	3917.9	3851.35	-1.7	3646.27	-5.32	14.36
LAC	1447.66	1708.88	18.04	1717.94	0.53	6.77
Asean	1462	1758.19	20.26	1598.76	-9.07	6.3
WANA	1320.44	1340.56	1.52	1481.76	10.53	5.84
South Asia	1238.02	1303.7	5.31	1151.49	-11.67	4.53
CIS	1177.96	1096.88	-6.88	1004.55	-8.42	3.96
NEA	823.98	803.71	-2.46	864.03	7.51	3.4
Oceania	428.23	465.61	8.73	518.79	11.42	2.04
Others	0.41	18.72	4466	30.82	64.64	0.12
Grand Total	24444.03	24594.27	0.61	25394.05	3.25	100

(*Source:* (*Pharmexcil_Annual_Report_2022-23.Pdf*, n.d.)

NAFTA region continues to be the top most region as an exporting partner. Almost a third of India’s exports are to this region. Exports to the Region of Europe have grown by

13.55% and are accountable for almost 20% of India's exports. Europe has a strong and robust pharma industry and in fact, it is the very crucible from which the global modern pharma industry has evolved. India's exports to this region have grown by over 12% only for the second time during the last ten years after FY-21 in which the growth rate was 18.45%. A significant percentage of India's exports to Africa is through different NGOs. These NGOs had diverted priorities and funds were not allocated to the routine medicine percentage which has dented India's exports. Africa has also stepped up its local production of essential drugs and initiated the setting up of six Vaccine plants. (*Pharmexcil_Annual_Report_2022-23.Pdf*, n.d.)

Figure 4.6 Region Wise Distribution of India's Pharma Exports



(*Pharmexcil_Annual_Report_2022-23.Pdf*, n.d.)

4.4 SPECIALIZATION AND ADVANTAGE

4.4.1 India's Normalised Revealed Comparative Advantage

The fourth section is what puts the domestic and global market together, the ability or the product India Specializes in, we shall take a look at the Normalised Revealed Comparative advantage.

Table 4.8. India's Normalised Revealed Comparative Advantage, Product at the first position and the Pharmaceutical standing for the years 1992-2022

Year	Country	NRCA Good	NRCAI
1992	India	Natural/cultured pearls, prec stone	0.0013018
		15. Pharmaceutical products.	0.0000737
1993	India	Natural/cultured pearls, prec stone	0.0013494
		18. Pharmaceutical products.	0.0000662
1994	India	Natural/cultured pearls, prec stone	0.0011383
		18. Pharmaceutical products.	0.0000518
1995	India	Natural/cultured pearls, prec stone	0.0010470
		17. Pharmaceutical products.	0.0000457
1996	India	Natural/cultured pearls, prec stone	0.0008610
		15. Pharmaceutical products.	0.0000497
1997	India	Natural/cultured pearls, prec stone	0.0008867
		14. Pharmaceutical products.	0.0000616
1998	India	Natural/cultured pearls, prec stone	0.0010463
		17. Pharmaceutical products.	0.0000421
1999	India	Natural/cultured pearls, prec stone	0.0013194
		16. Pharmaceutical products.	0.0000454

2000	India	Natural/cultured pearls, prec stone	0.0011650
		22. Pharmaceutical products.	0.0000419
2001	India	Natural/cultured pearls, prec stone	0.001069
		25. Pharmaceutical products.	0.0000299
2002	India	Natural/cultured pearls, prec stone	0.0012943
		32. Pharmaceutical products.	0.0000095
2003	India	Natural/cultured pearls, prec stone	0.0013326
		31. Pharmaceutical products.	0.0000107
2004	India	Natural/cultured pearls, prec stone	0.0012952
		49. Pharmaceutical products.	-0.0000033
2005	India	Natural/cultured pearls, prec stone	0.0014630
		71. Pharmaceutical products.	-0.0000185
2006	India	Natural/cultured pearls, prec stone	0.0011723
		41. Pharmaceutical products.	-0.0000003
2007	India	Natural/cultured pearls, prec stone	0.0012169
		55. Pharmaceutical products.	-0.0000048
2008	India	Natural/cultured pearls, prec stone	0.0010645
		33. Pharmaceutical products.	0.0000137
2009	India	Natural/cultured pearls, prec stone	0.0023638
		89. Pharmaceutical products.	-0.0001137

2010	India	Natural/cultured pearls, prec stone	0.0018842
		34. Pharmaceutical products.	0.0000131
2011	India	Natural/cultured pearls, prec stone	0.0023857
		20. Pharmaceutical products.	0.0000561
2012	India	Natural/cultured pearls, prec stone	0.0018901
		9. Pharmaceutical products.	0.0001463
2013	India	Natural/cultured pearls, prec stone	0.0017096
		8. Pharmaceutical products.	0.0001950
2014	India	Natural/cultured pearls, prec stone	0.0017310
		10. Pharmaceutical products.	0.0001878
2015	India	Natural/cultured pearls, prec stone	0.0019422
		6. Pharmaceutical products.	0.0003172
2016	India	Natural/cultured pearls, prec stone	0.0022354
		5. Pharmaceutical products.	0.0003305
2017	India	Natural/cultured pearls, prec stone	0.0018425
		9. Pharmaceutical products.	0.0002457
2018	India	Natural/cultured pearls, prec stone	0.0015895
		6. Pharmaceutical products.	0.0002592
2019	India	Natural/cultured pearls, prec stone	0.0014659
		3. Pharmaceutical products.	0.0003298

2020	India	Natural/cultured pearls, prec stone	0.0008394
		3. Pharmaceutical products.	0.0004779
2021	India	Natural/cultured pearls, prec stone	0.0011474
		7. Pharmaceutical products.	0.0002403
2022	India	Mineral fuels, oils & product of th	0.0016246
		10. Pharmaceutical products.	0.0001887

(Source: World Integrated Trade Solutions, WITS, the NRCA was calculated by the researcher)

a. Natural/Cultured Pearls, Precious Stones

Consistently higher NRCA compared to pharmaceuticals throughout the period (1992-2022). This indicates that India has a strong comparative advantage in exporting natural/cultured pearls and precious stones compared to other products, including pharmaceuticals. NRCA values for natural/cultured pearls, precious stones range from 0.0008394 (2020) to 0.0015 (2018) while pharmaceutical products range from -0.0004779 (2021) to 0.0003305 (2017).

b. Pharmaceuticals

NRCA values are generally negative or very low throughout most of the period. This suggests that India does not have a strong comparative advantage in exporting pharmaceuticals relative to other products it exports. However, there seems to be a positive trend from 2009 onwards, with NRCA reaching 0.0004779 in 2021. This could indicate a developing comparative advantage in pharmaceuticals.

c. Ranking

The ranking of pharmaceutical products relative to other products also reflects this trend. Pharmaceuticals are consistently ranked lower than natural/cultured pearls, precious

stones throughout most of the period. However, their rank has been improving in recent years. For instance, from being ranked 49th in 2004, pharmaceuticals reached 3rd place in 2020 and 2023.

Overall, the data suggests that while natural/cultured pearls, precious stones are a sector where India has a strong comparative advantage, pharmaceuticals are an emerging export sector for India.

4.4.2 Normalised Revealed Comparative Advantage of top 10 Major Producing Countries of Pharmaceutical Products.

Table 4.9. Normalised Revealed Comparative Advantage of top 10 Major Producing Countries of Pharmaceutical Products.

Year	1. USA	2. China	3. Germany	4. Japan	5. Ireland	6. Switzerland	7. France	8. Italy	9. India	10. Belgium
1992	-0.00026	-0.00016	0.00073	-0.00119	0.00044	0.00159	NULL	NULL	0.00007	NULL
1993	-0.00033	-0.00022	0.00073	-0.00128	0.00031	0.00138	NULL	NULL	0.00007	NULL
1994	-0.00036	-0.00027	0.00055	-0.00114	0.00035	0.00116	0.00051	-0.00016	0.00005	NULL
1995	-0.00051	-0.00028	0.00042	-0.00105	0.00029	0.00113	0.00053	-0.00012	0.00005	NULL
1996	-0.00044	-0.00028	0.00046	-0.00092	0.00038	0.00121	0.00055	-0.00007	0.00005	NULL
1997	-0.00048	-0.00036	0.00062	-0.00090	0.00044	0.00115	0.00063	0.00001	0.00006	NULL
1998	-0.00049	-0.00043	0.00084	-0.00099	0.00065	0.00134	0.00074	0.00001	0.00004	NULL
1999	-0.00039	-0.00051	0.00085	-0.00104	0.00060	0.00146	0.00082	0.00012	0.00005	0.00054
2000	-0.00005	-0.00051	0.00057	-0.00088	0.00050	0.00115	0.00083	0.00007	0.00004	0.00058
2001	-0.00017	-0.00079	0.00091	-0.00105	0.00097	0.00156	0.00108	0.00010	0.00003	0.00087

2002	-0.00038	-0.00115	0.00022	-0.00132	0.00187	0.00169	0.00113	0.00009	0.00001	0.00263
2003	-0.00011	-0.00141	0.00039	-0.00132	0.00167	0.00182	0.00114	0.00001	0.00001	0.00256
2004	0.00006	-0.00163	0.00103	-0.00136	0.00175	0.00188	0.00109	-0.00011	0.00000	0.00253
2005	0.00009	-0.00183	0.00121	-0.00128	0.00143	0.00192	0.00113	-0.00002	-0.00002	0.00256
2006	0.00014	-0.00197	0.00130	-0.00119	0.00124	0.00203	0.00105	-0.00009	0.00000	0.00243
2007	0.00003	-0.00232	0.00133	-0.00126	0.00235	0.00205	0.00100	-0.00019	0.00000	0.00251
2008	0.00016	-0.00229	0.00166	-0.00116	0.00252	0.00221	0.00109	-0.00012	0.00001	0.00230
2009	0.00039	-0.00336	0.00187	-0.00147	0.00424	0.00284	0.00140	-0.00016	-0.00011	0.00310
2010	0.00056	-0.00265	0.00205	-0.00120	0.00192	0.00280	0.00139	0.00031	0.00001	0.00049
2011	0.00025	-0.00236	0.00190	-0.00094	0.00187	0.00277	0.00111	0.00036	0.00006	0.00044
2012	0.00028	-0.00260	0.00207	-0.00095	0.00155	0.00275	0.00125	0.00032	0.00015	0.00038
2013	0.00019	-0.00271	0.00217	-0.00081	0.00129	0.00277	0.00131	0.00045	0.00019	0.00056
2014	0.00029	-0.00312	0.00224	-0.00086	0.00136	0.00312	0.00116	0.00045	0.00019	0.00061
2015	0.00047	-0.00389	0.00238	-0.00097	0.00185	0.00340	0.00102	0.00039	0.00032	0.00051
2016	0.00023	-0.00399	0.00227	-0.00110	0.00187	0.00391	0.00100	0.00040	0.00033	0.00104
2017	0.00009	-0.00358	0.00241	-0.00097	0.00204	0.00366	0.00094	0.00048	0.00025	0.00117
2018	0.00007	-0.00351	0.00270	-0.00088	0.00261	0.00359	0.00093	0.00007	0.00026	0.00121
2019	0.00015	-0.00395	0.00237	-0.00090	0.00266	0.00406	0.00099	0.00028	0.00033	0.00157
2020	0.00005	-0.00506	0.00276	-0.00100	0.00350	0.00456	0.00116	0.00034	0.00048	0.00205

2021	0.00058	-0.00388	0.00279	-0.00094	0.00285	0.00414	0.00083	0.00016	0.00024	0.00281
2022	0.00033	-0.00491	0.00302	-0.00082	0.00304	0.00378	0.00073	0.00028	0.00019	0.00271
2023	-0.00165	NULL	0.00522	NULL	NULL	0.01109	NULL	NULL	NULL	NULL

(Source: World Integrated Trade Solutions, WITS, the NRCA was calculated by the researcher)

NRCA is a metric used to assess a country's comparative advantage in exporting a particular good relative to other goods it exports. Here's a breakdown of the insights we can glean from this table for each country.

a. *United States:* The United States' NRCA for pharmaceuticals is mostly negative throughout the period, indicating a comparative disadvantage in this sector. However, there are a few positive values, and the NRCA appears to be less negative in recent years. The NRCA values range from -0.0039 (2020) to 0.0003 (1994).

Mostly negative NRCA indicates a comparative disadvantage for the US. However, there are a few positives and a slight improvement in recent years. This could be due to: High R&D costs and focus on innovative drugs. Outsourcing of manufacturing to countries with lower production costs.

b. *China:* China's NRCA negative values shouldnt be mistaken for low or less quality exports, definitely not, negative NRCA only suggests that China doesn't necessarily specialize in Pharmaceutical products but regardless their exports are high. China being the giant manufacturer whose products are labourforce flood all international markets with a variety of products from a variety of industries, the country has its hand full with many different industries and this competition would make them pay attention to a certain industry but that doesn't exclude them from the pharma market and so even though their values are in negative their exports are very high.

c. *Germany:* Germany's NRCA for pharmaceuticals is consistently positive throughout the period, indicating a comparative advantage in this sector. The NRCA values range from 0.0004 (1992) to 0.0022 (2008).

Consistently positive NRCA indicates a strong and stable comparative advantage in pharmaceuticals for Germany. This could be attributed to factors like:

1. A robust and efficient manufacturing base.
2. A skilled workforce in chemistry and pharmaceuticals.
3. Strong government support for R&D.

d. *Japan:* Japan's NRCA for pharmaceuticals is consistently positive throughout the period, indicating a comparative advantage in this sector. The NRCA values range from -0.0013 (1992) to 0.001 (2004).

Consistently positive NRCA signifies a strong comparative advantage in pharmaceuticals for Japan. This could be due to:

1. A highly advanced and innovative R&D sector.
2. Strong domestic market for pharmaceuticals.
3. Focus on high-quality and technologically advanced drugs

e. *Ireland:* Ireland's NRCA data for pharmaceuticals is not available for all years. However, the available data suggests a positive NRCA, particularly in recent years (from 2015 onwards). The highest NRCA for Ireland was 0.0042 (2020).

The positive NRCA in recent years indicates a potential comparative advantage. This could be due to presence of multinational pharmaceutical companies setting up manufacturing facilities in Ireland due to tax benefits and skilled workforce.

f. Switzerland: Switzerland's NRCA for pharmaceuticals is consistently positive throughout the period, indicating a comparative advantage in this sector. The NRCA values range from 0.0007 (1992) to 0.0022 (2008).

Similar to Germany and Japan, Switzerland enjoys a consistent comparative advantage, likely due to:

1. A long history of innovation in pharmaceuticals.
2. Presence of leading pharmaceutical companies with strong global brands.
3. Focus on high-value niche markets and specialty drugs.

g. France: Similar to Belgium, France's NRCA for pharmaceuticals fluctuates without a clear trend. It ranged from 0.00051 (2007) to 0.00168 (1992).

Fluctuating NRCA might be due to a focus on specific pharmaceutical segments. Analyzing France's pharmaceutical exports alongside its research and development (R&D) focus could shed light on their comparative advantage.

h. Italy: Italy's NRCA for pharmaceuticals fluctuates throughout the period, with both positive and negative values. There isn't a clear trend suggesting a strong comparative advantage or disadvantage. The NRCA values range from -0.00016 (1994) to 0.0011 (1992).

Italy's fluctuating NRCA suggests a mix of factors influencing their pharmaceutical exports.

A deeper look into Italy's pharmaceutical industry might reveal:

1. Strength in specific drug categories.
2. Dependence on imported raw materials, which could affect competitiveness in some years.

i. India: As discussed earlier, India's NRCA for pharmaceuticals is generally negative or very low throughout most of the period, suggesting a lack of comparative advantage. However, there seems to be a positive trend from 2009 onwards, with NRCA reaching 0.0004779 (2021).

This trend could be due to:

1. Growing production of generic drugs.
2. Increasing government investment in pharmaceutical infrastructure and R&D.

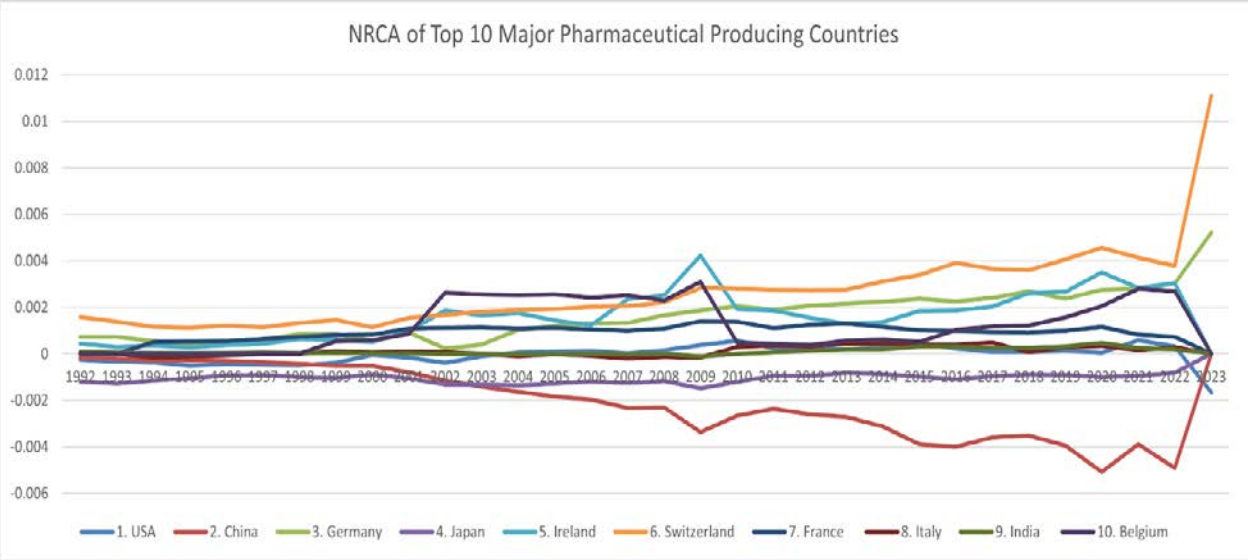
3. Cost-competitive workforce.

j. Belgium: Belgium's NRCA for pharmaceuticals fluctuates throughout the period, with both positive and negative values. It reached a high of 0.00183 (2005) and a low of -0.00016 (1994). There isn't a clear trend suggesting a strong comparative advantage or disadvantage.

Similar to France, Belgium's Fluctuating NRCA suggests Belgium's pharmaceutical industry might be focused on niche markets or specific types of drugs, leading to variations in comparative advantage year-to-year. Further investigation into Belgium's pharmaceutical exports could reveal these specializations.

Factors like strong research institutions or manufacturing capabilities for certain drug types could be influencing their NRCA.

Figure 4.7. NRCA of Top 10 Major Pharmaceutical Producing Countries



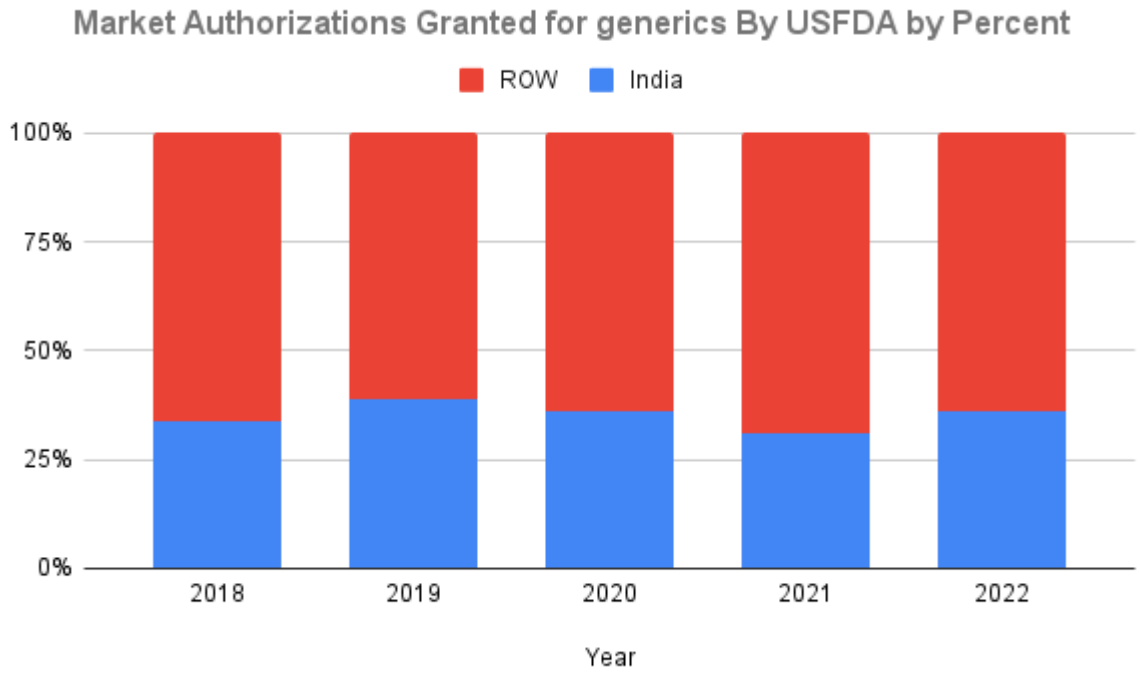
Overall, the data suggests that several countries, including Germany, Japan, and Switzerland, have a consistent comparative advantage in exporting pharmaceutical products. India's pharmaceutical sector is an emerging export sector, while the United States seems to be at a comparative disadvantage. Countries with high R&D spending are more likely to develop innovative drugs and have a comparative advantage. Efficient and cost-effective manufacturing

infrastructure is crucial for competitiveness. Supportive government policies can encourage R&D, attract investments, and improve the competitiveness of the pharmaceutical industry.

4.4.3 Market Authorization Granted For Generics By Usfda By Percent

"Market authorizations of USA" typically refers to the process and approval granted by the US Food and Drug Administration (FDA) for a product to be marketed and sold in the United States. In the context of pharmaceuticals, biologics, medical devices, and other regulated products, market authorization is often synonymous with FDA approval or clearance.

Figure 4.8 Market Authorizations Granted for generics By USFDA by Percentage



(Pharmexcil_Annual_Report_2022-23.Pdf, n.d.)

Over the years India as a single country has been bagging the largest number of Market authorizations of the USA (more than 30% of Market authorizations over the last five years).

Strong Pharmaceutical Industry: India has a robust and well-established pharmaceutical industry known for producing high-quality generic drugs and active pharmaceutical ingredients (APIs). Many Indian pharmaceutical companies have extensive experience in drug

development, manufacturing, and compliance with regulatory standards required by the US Food and Drug Administration (FDA).

a. Regulatory Compliance

Indian companies have made significant investments in meeting stringent regulatory requirements set by the FDA and other international regulatory agencies. This includes adherence to good manufacturing practices (GMP) and quality standards, which are essential for obtaining approvals for selling pharmaceutical products in the US market.

b. Competitive Pricing

Indian pharmaceutical products are often competitively priced compared to branded counterparts, making them attractive to consumers and healthcare providers in the USA. This cost advantage contributes to the increased market share of Indian pharmaceuticals in the US market.

c. Focus on Research and Development

Many Indian pharmaceutical companies are increasingly investing in research and development (R&D) to develop new drugs and formulations. This emphasis on innovation and product development enhances their competitiveness and capability to introduce new products to the US market.

d. *Skilled Workforce and Infrastructure*

India has a large pool of skilled scientists, researchers, and engineers who contribute to the success of pharmaceutical and biotechnology companies. Additionally, the country has developed specialized infrastructure and technology hubs that support advanced research and manufacturing capabilities.

e. International Partnerships and Collaboration

Indian pharmaceutical companies often engage in strategic partnerships, collaborations, and acquisitions with global companies to expand their market reach and gain access to new technologies and markets, including the USA.

f. Government Support and Policies

Supportive government policies and initiatives aimed at promoting exports and fostering innovation in the pharmaceutical sector have also played a role in India's success in obtaining market authorizations in the USA.

4.5 ACQUISITION AND STRATEGY

The final section deals with the M&A's that have taken place in the Indian Pharmaceutical Industry since 1992.

4.5.1 Mergers and Acquisitions (M&A) in the Indian Pharmaceutical Industry: A Strategic Boost

Mergers and Acquisitions (M&A) are significant events in the business world, and the Indian pharmaceutical industry is no stranger to this phenomenon. These deals involve the consolidation of companies, where one entity (acquirer) takes over another (target) or merges with it to create a new entity. M&A activity plays a crucial role in shaping the competitive landscape of the industry and offers several advantages for the companies involved.

Table 4.10 Some of The Mergers and Acquisitions from 1992-2023 in the IPI

Target Company	Date	Asset name	Acquirer	Event Date
Ajanta Pharma Ltd.	2000	Bulk drug unit	Orchid Pharma Ltd.	2000
	2011	Medicine brand, '30-Plus'	Dabur India Ltd.	2011
Alpa Laboratories Ltd.	2014	Unit-II (High Potency Oral Solid Dosage Manufacturing Unit)	Ipca Laboratories Ltd.	2014
American Remedies Ltd. [Merged]	1999	Bulk Drugs Plant	Sanmar Performance Chemicals & Research Services Ltd.	1999
	2000	Bulk Drugs facility	Trifarma, Italy	2000
Anglo-French Drugs & Inds. Ltd.	2022	Portfolio Of Brands	Lupin Ltd.	2022
Aurobindo Pharma Ltd.	2000	Trading operations	Aurobindo Natural Products	2000
	2002	Pondicherry Bulk Drug Unit	Not Known	2003
	2005	Non-regulatory Manufacturing Facility	Jupiter Bioscience Ltd.	2006
	2013	Injectables Unit IV	Curepro Parenterals Ltd. [Merged]	2014
	2021	Business Undertaking	A P L Healthcare Ltd.	2021
	2021	The Unit 16	Wytells Pharma Pvt. Ltd.	2021
	2021	The Unit 4	Eugia Pharma Specialities Ltd.	2021
	2023	API Non-Antibiotic & API Antibiotic Business	Auro Pharma India Pvt. Ltd.	2023
Bafna Pharmaceuticals Ltd.	2014	India Branded Generics Business	Strides Pharma Science Ltd.	2014
Biocon Biologics Ltd.	2023	BFI Non-Core Business	Eris Lifesciences Ltd.	2023
Biocon Ltd.	2007	Enzymes business	Novozymes South Asia Pvt. Ltd.	2007

	2017	Biosimilars Business	Biocon Biologics Ltd.	2017
	2019	Branded Formulations India (BFI) Business	Biocon Biologics Ltd.	2019
Brabourne Enterprises Ltd. [Merged]	2001	Agrochemicals division	Isagro (Asia) Agrochemicals Pvt. Ltd. [Merged]	2001
	2007	Investments	Instant Holdings Ltd.	2007
Cachet Pharmaceuticals Pvt. Ltd.	2019	Pharmaceutical	Alkem Laboratories Ltd.	2019
Cipla Ltd.	2010	Contraceptive brand,	Piramal Enterprises Ltd.	2010
	2015	Consumer Healthcare Business	Cipla Health Ltd.	2015
	2021	US Business undertaking	Cipla Pharma & Life Sciences Ltd.	2021
	2023	Generic (Gx) Business	Cipla Pharma & Life Sciences Ltd.	2023
Claris Lifesciences Ltd.	2012	Infusion Division	Otsuka Pharmaceutical India Pvt. Ltd.	2012
	2014	Speciality Injectable Business	Baxter Pharmaceuticals India Pvt. Ltd.	2014
	2016	Global Generic Injectables Business	Baxter International	2017
Dishman Pharmaceuticals & Chemicals Ltd. [Merged]	2016	Effluent Treatment Plants Undertaking	Dishman Carbogen Amcis Ltd.	2017
Dr. Reddy'S Laboratories Ltd.	2023	Nine Cosmetic Dermatology Brands	Eris Lifesciences Ltd.	2023
Elder Pharmaceuticals Ltd.	2000	Consumer products marketing division	Elder Health Care Ltd.	2000
	2013	Domestic Branded Formulation Business	Torrent Pharmaceuticals Ltd.	2013
Eli Lilly & Co. (India) Pvt. Ltd.	1999	Pharmaceutical brands	Piramal Enterprises Ltd.	2000
Fem Care Pharma Ltd. [Merged]	2008	Speciality Chemical Division	Unknown	2008
Glaxosmithkline Pharmaceuticals Ltd.	2000	Multivite FM & Macraberin pharma brands	Universal Medicare Pvt. Ltd.	2000

	2000	Pharma brands Anovate & Derobin	U S Vitamins Ltd.	2000
	2000	Liver tonic - Livogen	E Merck	2000
	2001	Commercial property	Hongkong & Shanghai Banking Corpn. Ltd.	2001
	2001	Iodex brand	Glaxosmithkline Consumer Healthcare Ltd. [Merged]	2001
	2002	Ankleshwar unit	Glenmark Pharmaceuticals Ltd.	2002
	2003	Bangalore Office Premises	Dawat-E-Hadiyah Trust	2003
	2004	Commercial property	I-Ven Realty Ltd.	2004
	2005	Commercial Land	Oberoi Constructions Ltd. [Merged]	2005
	2006	Animal Health Business	Vibrac Animal Health India Pvt. Ltd.	2006
	2007	Fine Chemical Business	Thermo Fisher Scientific India Pvt. Ltd.	2007
	2019	ENTEROPLUS Trademark/Brand	F D C Ltd.	2019
Glenmark Pharmaceuticals Ltd.	2000	Pesticide division	Transfer To A Separate Company	2000
	2007	Generics and Active Pharmaceutical Ingredients (API) businesses	Glenmark Generics Ltd. [Merged]	2008
	2018	Active Pharmaceuticals Ingredient	Glenmark Life Sciences Ltd.	2018
	2020	Gynaecology Business	Integrace Pvt. Ltd.	2020
	2020	Hygiene brand 'VWash	Hindustan Unilever Ltd.	2020
	2022	Razel	J B Chemicals & Pharmaceuticals Ltd.	2022
	2023	Tail Brands	Eris Oaknet Healthcare Pvt. Ltd.	2023
Group Pharmaceuticals Ltd.	2001	Dental care prescription brands	Dr. Reddy'S Laboratories Ltd.	2001

Ind-Swift Laboratories Ltd.	2021	Active Pharmaceutical Ingredients Business Division	P I Industries Ltd.	2021
	2023	Active Pharmaceuticals Ingredients & CRAMS Business	Synthimed Labs Pvt. Ltd.	2023
Infutec Healthcare Ltd.	2013	Pharmaceutical Manufacturing Unit	Fresenius Kabi India Pvt. Ltd.	2013
J B Chemicals & Pharmaceuticals Ltd.	2011	Russia - C I S OTC Business	Cilag Gmbh International	2011
	2011	Russia - C I S Prescription Products Business	Dr. Reddy'S Laboratories Ltd.	2011
Kilitch Drugs (India) Ltd.	2011	Business of Generic Pharmaceutical Formulation	Akorn India Pvt. Ltd.	2011
Kopran Ltd.	1999	Semi synthetic penicillin bulk drugs division	K D L Biotech Ltd.	1998
	2001	Anti-hypertensive brand - Aten	Zydus Lifesciences Ltd.	2001
	2005	Vent, Tini, Bid Brands	Merck Specialities Pvt. Ltd.	2005
	2008	Smyle brand	Maneesh Pharmaceuticals Ltd.	2008
	2014	Active Pharmaceutical Ingredient (API) Business	Kopran Research Laboratories Ltd.	2014
	2015	Consumer Care Division	Kopran Lifestyle Ltd.	2015
Lupin Laboratories Ltd. [Merged]	1999	Real estate	Piramal Enterprises Ltd.	1999
Lyka Labs Ltd.	2000	Three pharma brands	Glenmark Pharmaceuticals Ltd.	2000
	2002	Formulation brands	Lyka Hetero Health Care Ltd.	2002
	2002	Veterinary brands	Lyka Exports Ltd. [Merged]	2002
	2003	Export Division	Transfer To 50:50 Jv With Bdr Pharmaceuticals Intl. Pvt. Ltd.	2003
	2014	Domestic Marketing Division of Ethical products	Lyka Healthcare Ltd. [Merged]	2014
Natco Pharma Ltd.	1999	Domestic finished pharmaceutical brands	Sun Pharmaceutical Inds. Ltd.	1999

	2000	Bulk drug division	Transfer To Joint Venture Company	2000
Novartis India Ltd.	1997	Speciality Chemicals business	Ciba India Ltd. [Merged]	1997
	1999	Real estate	Toyota India	1999
	1999	Agrochemicals manufacturing unit.	Hikal Ltd.	1999
	2000	Agribusiness Undertaking	Syngenta India Pvt. Ltd.	2000
	2001	Land at Goregaon	Oberoi Realty Ltd.	2001
	2005	Rifampicin Bulk Drug	Sandoz Pvt. Ltd.	2005
	2014	Animal Health Division	Elanco India Pvt. Ltd.	2014
	2015	OTC Division	Glaxosmithkline Consumer Pvt. Ltd.	2015
Orchid Pharma Ltd.	2009	Injectable Pharmaceuticals business	Hospira	2010
	2012	Penicillin & Penem Active Pharmaceutical Ingredients Business	Pfizer Healthcare India Pvt. Ltd.	2012
Pfizer Ltd.	1999	Plant	Zydus Lifesciences Ltd.	1999
	2002	Protinex brand	Dumex India Pvt. Ltd.	2002
	2004	Ankleshwar Plant	Anodyne Remedies India Ltd.	2004
	2004	Intra Ocular Lens Unit	Advanced Medical Optics	2004
	2007	Fermentation plant (Chandigarh)	C S J Infrastructure Pvt. Ltd.	2007
	2015	Pharmaceutical Business at Thane Plant	Vidhi Research & Devp. L L P	2023
Ranbaxy Laboratories Ltd. [Merged]	1999	Pharmaceutical brands	Galderman S A, France	1999
	1999	Phamaceutical brand (Lovir)	Piramal Enterprises Ltd.	1999

	2005	Diagnostics, Fine Chemicals and Animal Health Divisions	I C I C I Venture Funds Mgmt. Co. Ltd.	2005
	2008	New Drug Discovery Research (NDDR) unit	Ranbaxy Life Sciences Research Ltd. [Merged]	2008
Somerset Therapeutics Ltd.	1999	Bulk drug unit	Saklaspur Bio Tech Pvt. Ltd.	1999
	2000	Formulations business	Zydus Lifesciences Ltd.	2000
	2001	R&D and Bulk Drugs manufacturing facility	Hikal Ltd.	2001
	2014	Trade Marks & Marketing Division	Bangalore Pharmaceutical & Research Laboratory (P) Ltd.	2014
	2018	Pharmaceutical Business Undertaking	P A R Formulations Pvt. Ltd.	2019
Sun Pharmaceutical Inds. Ltd.	2006	Innovative Research & Development Business	Sun Pharma Advanced Research Co. Ltd.	2007
	2012	Domestic Formulation Undertaking	Sun Pharma Laboratories Ltd.	2013
	2015	Solus and Solus Care Division	Strides Pharma Science Ltd.	2016
	2018	Specified Investment Undertaking-1	Sun Pharma (Netherlands) B V	2018
Syngene International Ltd.	2023	Hyderabad Operations	Syngene Scientific Solutions Ltd.	2023
Themis Medicare Ltd.	2022	Active Pharmaceutical Ingredients (API) Business	Themis Lifestyle Pvt. Ltd.	2022
Torrent Pharmaceuticals Ltd.	2001	Glucomol brand	Allergan India Pvt. Ltd.	2001
	2002	Valparin brand	Sanofi-Synthelabo (India) Pvt. Ltd.	2002
Twilight Litaka Pharma Ltd.	2013	Manufacturing Unit	Herbalife International India Pvt. Ltd.	2013
Universal Medicare Pvt. Ltd.	2011	Nutraceutical business	Sanofi India Ltd.	2011
Watson Pharma Pvt. Ltd.	2022	Active Pharmaceutical Ingredients Business	Zydus Lifesciences Ltd.	2023
Zydus Lifesciences Ltd.	2000	Diagnostics business	Transfer To Separate Company	2000

	2003	Real estate	Not Known	2003
	2008	Consumer Products Division	Zydus Wellness Ltd.	2008
	2016	India Human Formulations Undertaking	Zydus Healthcare Ltd.	2016
	2020	Animal Healthcare Business	Zydus Animal Health & Investments Ltd.	2020

(Source: CMIE's Prowess IQ, Mergers and Acquisitions from 1992-2023 in the Pharmaceutical Industry)

4.5.2 Importance of M&A in Indian Pharma

a. *Market Access and Expansion:* Acquiring established players or brands allows companies to gain access to new markets or strengthen their presence in existing ones. This can be particularly beneficial for Indian pharma companies looking to expand their global footprint.
b. *Product Portfolio Enhancement:* M&A can be a strategic tool to acquire complementary product lines or fill gaps in a company's portfolio. This allows them to cater to a wider range of therapeutic areas and customer needs.
c. *Research & Development (R&D) Boost:* Acquiring companies with promising drug pipelines or strong R&D capabilities can accelerate innovation and shorten the time to market for new drugs. This is crucial in the competitive pharmaceutical landscape.
d. *Economies of Scale and Scope:* Merging with or acquiring another company can lead to cost savings through economies of scale (bulk purchasing, shared resources) and economies of scope (utilizing existing infrastructure for new products).
e. *Enhanced Expertise and Talent Acquisition:* M&A can provide access to specialized talent, expertise, and technological capabilities that can be leveraged to gain a competitive edge.

4.5.3 Reasons for M&A Activity in the Indian Pharmaceutical Industry

a. *Increased Competition:* The Indian pharmaceutical industry is witnessing growing competition from both domestic and global players. M&A can be a way to consolidate resources and gain a stronger market position.
b. *Patent Expiries:* The expiration of patents on major drugs can lead to revenue losses. Companies may seek acquisitions to diversify their product portfolios and mitigate this risk.
c. *Focus on Specialty Drugs:* The industry is shifting towards specialty drugs with higher margins. M&A can be a way to acquire companies with expertise in these areas.
d. *Rising R&D Costs:* Developing new drugs is a time-consuming and expensive process. M&A can be a faster and more cost-effective way to gain access to promising drug candidates.
e. *Government Initiatives:* The Indian government's initiatives to promote consolidation and innovation in the pharmaceutical sector can also encourage M&A activity.

4.5.4 Examples of M&A in Indian Pharma

The Indian pharmaceutical industry has witnessed several significant mergers and acquisitions (M&A) over the years, reshaping the landscape of the sector. Here are some notable M&A deals that have occurred in the Indian pharmaceutical industry:

a. *Sun Pharmaceutical Industries and Ranbaxy Laboratories (2014):* One of the largest deals in the Indian pharmaceutical industry, Sun Pharmaceutical Industries acquired Ranbaxy Laboratories in 2014 for approximately $3.2 billion. This acquisition helped Sun Pharma strengthen its position globally and expand its product portfolio.
b. *Piramal Healthcare and Abbott Laboratories (2010):* In 2010, Abbott Laboratories acquired Piramal Healthcare's domestic formulations business for approximately $3.7

billion. This deal allowed Abbott to expand its presence in the Indian pharmaceutical market and gain access to Piramal's portfolio of branded generics.

c. *Dr. Reddy's Laboratories and Betapharm (2006):* Dr. Reddy's Laboratories, a leading Indian pharmaceutical company, acquired Betapharm, a German generic pharmaceutical company, in 2006 for around €480 million. This acquisition marked Dr. Reddy's entry into the European market and provided a platform for further international expansion.

d. *Cipla and Medpro South Africa (2013):* Cipla, a prominent Indian pharmaceutical company, acquired a majority stake in Medpro South Africa in 2013 for approximately $512 million. This strategic acquisition helped Cipla strengthen its presence in the African pharmaceutical market.

e. *Aurobindo Pharma and Natrol Inc. (2014):* Aurobindo Pharma acquired Natrol Inc., a U.S.-based dietary supplements manufacturer, in 2014 for around $132.5 million. This acquisition enabled Aurobindo to diversify its product portfolio and enter the lucrative dietary supplements market in the United States.

f. *Strides Shasun and Shasun Pharmaceuticals (2014):* Strides Shasun, an Indian pharmaceutical company, acquired Shasun Pharmaceuticals in 2014 to create a larger entity with a diversified product portfolio and enhanced manufacturing capabilities.

g. *Lupin and Gavis Pharmaceuticals (2015):* Lupin Limited acquired Gavis Pharmaceuticals, a U.S.-based specialty pharmaceutical company, in 2015 for approximately $880 million. This acquisition helped Lupin strengthen its presence in the U.S. generic drugs market.

These mergers and acquisitions reflect the global ambitions of Indian pharmaceutical companies seeking to expand their footprint, access new markets, acquire technology and capabilities, and enhance competitiveness in the dynamic pharmaceutical industry. Each deal

has played a significant role in shaping the growth trajectory and strategic direction of the companies involved.

4.5.5 Some Instances Of M&A In The Indian Pharmaceutical Industry Driven By R&D:

a. *Sun Pharma acquisition of Cara Therapeutics (2015):* Sun Pharma, a major Indian pharmaceutical company, acquired Cara Therapeutics, a US-based firm developing innovative drugs for chronic itching. This deal provided Sun Pharma access to Cara's late-stage pipeline, specifically KORSUVA, an itching treatment with promising results.
b. *Lupin's acquisition of Gavis Pharmaceuticals (2015):* Lupin, another leading Indian pharma player, acquired Gavis Pharmaceuticals, a US-based company specializing in niche generic drugs. This move aimed to strengthen Lupin's presence in the US market and gain access to Gavis' R&D capabilities for developing new generic formulations.
c. *Dr. Reddy's acquisition of Seven Hills Pharma (2012):* Dr. Reddy's Laboratories, a prominent Indian pharmaceutical company, acquired Seven Hills Pharma, a smaller Indian firm with a strong focus on biosimilars (generic versions of complex biologic drugs). This acquisition bolstered Dr. Reddy's biosimilars portfolio and R&D expertise in this growing area.

CHAPTER 5: RESULTS & DISCUSSION

5.1 THE OBJECTIVES OF THE NATIONAL PHARMACEUTICAL POLICY IN INDIA

5.1.1 Fostering Global Pharmaceutical Leadership

The policy envisions India's transformation into a prominent global R&D hub for the pharmaceutical industry, shifting from a volume-based to a value-based leadership model, underpinned by world-class research infrastructure, thereby enhancing the nation's global standing.

5.1.2 Promoting Self-Reliance

Aligned with the "Atmanirbhar Bharat" (Self-Reliant India) initiative, the policy aims to fortify national capabilities and sovereignty, endorsing the "Make in India" drive to ensure self-sufficiency in pharmaceutical production with a renewed focus on Quality.

5.1.3 Advancing Health Equity and Accessibility

The policy is committed to advancing health equity by ensuring that quality medicines and healthcare services are accessible and affordable to all citizens, reducing disparities in healthcare access.

5.1.4 Attracting Foreign Direct Investments

One of the key objectives is to create an environment conducive to attracting foreign investments in the Indian pharmaceutical sector, fostering economic growth, innovation, and global collaborations.

5.1.5 Enhancing Regulatory Efficiency

The policy underscores the harmonization of regulatory approvals and an emphasis on transparency in pricing mechanisms, streamlining processes, and promoting ease of doing business in the pharmaceutical industry's regulatory framework. (Bansal, 2023)

5.2 IMPACT OF THE POLICIES AND SCHEMES ON THE IPI

The three mentioned schemes (Production Linked Incentive Schemes for Bulk Drugs [PLI 1.0], Production Linked Incentive Scheme for Pharmaceuticals [PLI2.0], Bulk Drugs Pharma Schemes) along with the National Pharmaceutical Policy were very crucial in shaping the Indian Pharmaceutical Industry. It is very important to understand that there is no particular National Pharmaceutical Policy that caused the change, the ball was set rolling by the National Pharma Policy in 1970, and since then there have been major changes introduced to work with liberalization, the TRIPS agreement, and the growing competition. The National Pharmaceutical Policy of 2002 surely played a major role along with the 2012 policy. While we cannot directly figure out or conclude that these policies only led to the changes in the industry and everything else was constant, we could credit some of the success of the policies, this research seeks to pick and study variables and study their change over the years. The years 1992-2023 were chosen because they represent the “change over” or “getting used to” period. 1972 was when the first National Pharmaceutical Policy came into the act, 1970-1990 was basically India producing for domestic consumption and meeting minor trade challenges. 1992 was the birth of liberalization and even though there was trade taking place before 1992, liberalization opened new doors to the global market for the IPI to explore therefore the change-over is very evident with the Exports/Sales/R&D Expenditure.

The objective of the National Pharmaceutical policy states that they aspire to make India the global R&D hub for pharmaceutical industries. In another objective, the infrastructure is spoken about, and for the purpose of this research infrastructure and R&D are combined and split into R&D capital and R&D Current, investing in capital and current has spillover effects. The results of the VAR model are evidence that our null hypothesis is false and that there in fact is a causal relationship between R&D and Export performance, this is proven by the fact that increased investments in the R&D Capital Expenditure lead to an increased/high

Pharmaceutical Export, but high investment in R&D Current Expenditure does not necessarily increase the Exports, instead high Exports could potentially lead to high R&D Current Expenditure. Similarly investing highly in R&D Capital Expenditure leads to an investment in the current R&D expenditure. High Pharmaceutical Exports lead to a slight increase in the investment in R&D Capital Expenditure but a major increase in the R&D Current expenditure but High Pharmaceutical Sales most definitely lead to high R&D Capital Expenditure. R&D Current expenditure heavily depends on the level of expenditure of the past periods, while high Pharmaceutical Exports lead to an increase in the R&D Current Expenditure, a high R&D Capital Expenditure may lead to a lower R&D Current investment in the following year. The Pairwise Granger Causality Test run using 2-year lag and 3-year lag models shows similar evidence, Pharmaceutical Exports causes a change in R&D Capital Expenditure as well as R&D Current Expenditure and R&D Capital expenditure too causes a change in Pharmaceutical Exports but there is no evidence for the 2 year lag model and the 3 year lag model to support the fact that R&D Current Expenditure causes a change in Pharmaceutical Exports neither R&D Capital Expenditure, but in both cases the opposite is true that R&D Capital Expenditure when invested in can change R&D Current Expenditure.

There has been a general downward trend in the Concentration ratios and Herfindahl Hirschman Index which signifies that contrary to the scenario in 1992, 2023 sees a lot of competition in the Indian Pharmaceutical Industry, which proves the hypothesis that there will be no significant change in the concentration of the Indian pharma market wrong, the downward trend supports the decision that the hypothesis was false and there was a significant decrease in the concentration. This helps justify the concentration of profits, exports, and total income. With 940 companies in the Indian Pharmaceutical Industry, the share of Pharmaceutical Exports among India’s total Exports has constantly been on the rise while the contribution of Indian pharmaceutical products export to the world's pharmaceutical export has

also seen a rise. Since 1992 there has been a surplus in the Export/Import ratio of Pharmaceutical trade which paints a good picture of healthy and profitable trade. The excess exports to the marginal pharma imports are a sign that the Indian market is dominated by our own products while foreign companies do exist, some have set up shops here and even gone to the extent of merging with Indian Pharmaceutical Companies. The null hypothesis that the specialization of pharmaceutical products has no comparative advantage as compared to products of other industries was false, the NRCA ratio shows that the pharma products do have a comparative advantage and that pharmaceutical products have seen an improvement in the ratio over time. While India has an absolute advantage in the production and exports of Natural/Cultured stones, Pharmaceutical products are not far behind, from a very low position it has fought its way to the top proving that the Indian Pharmaceutical Industry is indeed growing very rapidly.

There is a significant difference in the motivations for recent acquisitions in the Indian pharmaceutical industry compared to motivations driven solely by financial considerations or short-term gains. Mergers and Acquisitions take place a company with a strong existing product line might acquire a smaller firm that's developing a breakthrough drug in late-stage clinical trials. Two companies with R&D strengths in different therapeutic areas can merge to create a powerhouse. This allows them to leverage each other's expertise in drug discovery, development, and commercialization across a wider range of diseases, a popular example is that of GlaxoSmithKline and Human Genome Sciences merging their oncology and gene therapy R&D. Merging can lead to economies of scale in R&D. The combined entity can eliminate duplicate research efforts and optimize resource allocation across shared facilities, personnel, and technologies, potentially leading to faster drug development.

CHAPTER 6: CONCLUSION

Since the dawn of liberalization, the Indian Pharmaceutical Industry has seen a lot of change, it has transitioned and sought the title “Pharmacy of the Developing world.” From a country that was only involved in the packaging and manufacture of generics, India has transitioned into innovation by investing in its infrastructure and Research & Development. Present scenario India is a strong competitor in achieving Global Trade Supremacy. The National Pharmaceuticals Policy vision for 2047 is to make India a global hub for pharma research and development activities. The objectives of the research paper were to present the overview, trade competitiveness, and policy implications of structural changes in Indian Pharmaceuticals, especially after the enactment of the Product Patent Act which includes market structure, ownership pattern, trade performance, R&D expenditure, and mergers and acquisitions, and alongside to study the causal link between R&D expenditure, exports, and the size of the pharmaceutical industry. If we revisit the hypothesis in the Results and Discussions chapter, we realize that over time there were significant changes that took place in the Indian Pharmaceutical market’s concentration, the decrease in the concentration ratio is evidence that there are no longer a few companies that hold market power, while there are giant companies the competition is strong due to the presence of big and small players. The VAR models and the Pairwise Granger Causality test show a causal relationship between R&D (Capital + Current) expenditure and export performance. They provide results that use lagged data to predict that investment in a part variable, for instance, R&D Capital Expenditure will most definitely result in increased exports in the following year. The share of the Indian market held by foreign companies has decreased over time, and India’s imports of pharma products are very marginal as compared to their exports, since 1992 there has been a growing trend of increased surplus where India’s exports of pharmaceutical products have seen an increase over time in

the global scenario too. Even though it is marginal the comparative advantage of pharmaceutical products has improved over time, even though it is not the one with the highest ratio, the position has been improving with fluctuations. The hypothesis that there is no significant difference in the motivations for recent acquisitions in the Indian pharmaceutical industry compared to motivations driven solely by financial considerations or short-term gains is false, as the research signifies, mergers and acquisitions take place for a long list of reasons, and yes while ultimately there is the goal of profits, the changes made in the short term to drive those long term gains is what's crucial.

The Indian Pharmaceutical Industry has seen a transformation, with the introduction of product patents in 1995 and with the TRIPS agreement introduced in 1995 which was put into play somewhere in 2005, the Indian Pharmaceutical industry saw a delay and a minor change, but nonetheless, there was a change. The competition has increased since 1992 with a lot of new companies setting up shops with the schemes and policies at hand, the TRIPS agreement and liberalization incentivized companies to enter the market and face the competition, but competition is always good as it encourages a company to work hard to stand out and that’s exactly how it played out, instead of making investments in advertising or packaging, companies started investing on research and development. Indian companies have either acquired or merged with foreign companies, and the ownership patterns in the IPI have seen healthy change. R&D investments have seen a hike, and while many companies join forces to put together R&D abilities for some it is the only way to keep up with the competition. Since 1992 India has enjoyed a surplus in the Pharmaceutical Trade, where they export more than they import, while earlier the scenario was different, one where we packaged what China fed us and exported, upon investing in research and development, the VAR model showed how it can directly increase Exports. Since 1992, there have been huge investments made into the pharmaceutical industry, R&D has seen a huge jump, it was gradual but upon looking at the

data in the Methodology section, the investments made in R&D Capital and Current expenditure have kept growing.

“Pharmacy of the developing world” must've made you believe that the Pharmaceutical trade is India’s greatest strength but that isn’t the case, the NRCA has shown how Natural/cultured pearls and prec stone has an absolute advantage while the position of Pharmaceuticals on the rise, their ratios have been positive except two cases showing that they have a comparative advantage.

The incentives that M&A provides are highlighted in this paper with regards to the primary variable R&D, there have been attempts to acquire and merge with companies purely because of their R&D infrastructure and progress, it may not always succeed but there are great positives that come out of it. It is very important to remember that while this paper provides us with examples that highlight R&D as a factor, M&A deals in the Indian pharma industry can have multiple motivations, access to new markets, expansion of product offerings, and acquiring established distribution networks also play a significant role.

The whole motive behind this research is a personal belief, the Indian pharmaceutical Industry has taken birth and has now taken shape, these research findings point us towards growth and success, the IPI has a long way to go and a lot to achieve. If all the stakeholders realize what’s at stake here and act in the favour of the industry, I would go to the extent of saying it could be the thing that resolves the issue of poverty in India. This research has served its purpose and has arrived at the conclusions that it predicted. I hope the industry achieves what it’s destined for and I hope we Indians see it succeed.

CHAPTER 7: RECOMMENDATIONS

If this research would be summed up in a few words to answer the question, what is important to have the Indian Pharmaceutical Industry grow? The answer would be 'Invest in R&D.', the answer has been out there for a long time and stakeholders have made moves to benefit the industry. Going a mile ahead would be to encourage more R&D with the motive of filing for more patents, and as of right now, that is in the way of India achieving global supremacy, PATENTS. Patents unlock a lot of big doors to competitive markets and the gates to profits. They allow India to grow and reach out further than they are supposed to. As for the results of this research, that is the only recommendation that is permitted. The country needs to focus on generics and essential drugs, India has a strong reputation for producing affordable generic drugs. Continued focus on this area will ensure essential medicines remain accessible to both domestic and international markets. Collaborating, with policymakers to develop sustainable pricing models that balance affordability for patients with the need for industry profit to fund research and development. Additionally invest in new drug discovery, move beyond just generics, and focus on discovering and developing new drugs for unmet medical needs. This will require increased investment in R&D infrastructure and talent. Upgrade manufacturing facilities, Invest in modernizing manufacturing plants to meet international quality standards and improve efficiency. Focus on stringent quality control and implement robust quality control measures throughout the production process to ensure patient safety and build trust in Indian pharmaceuticals.

CHAPTER 8: SCOPE FOR FUTURE RESEARCH

The Pharmaceutical Industry is a huge deal, on paper as well as in reality. This research may have overlooked a lot of finer details that matter, the industry and the public database have a lot to offer to future researchers. There is a huge stock of studies and research papers already existing, which with the way India is progressing can't keep up, while the study is relevant, there could be gaps that need to be answered. Post 2024- 2025, many patents are expiring, India will up its investments in many sectors and it has already begun with the numbers visible in the R&D Investment, this will create a further gap. The Indian Pharmaceutical Industry is a giant, but future research can unlock even greater potential. We can leverage the vast amount of industry and public data through techniques like data mining to uncover hidden trends and unmet medical needs. Additionally, stronger collaboration between researchers, companies, and regulators can bridge the gap between research and practical applications. The upcoming patent cliff post-2025 presents an opportunity for generic drug development, while India's surge in R&D investment calls for research into optimizing resource allocation and fostering innovation. Furthermore, India's strength in natural products can be explored by integrating traditional medicine with modern science and researching sustainable practices. Finally, in-depth studies of specific products and benchmarking against global leaders can provide valuable insights for industry growth. By exploring these avenues, future research can propel the Indian Pharmaceutical Industry to even greater heights. Similarly, one could even explore Natural/cultured pearls, prec stone which has had an absolute comparative advantage in the Indian manufacturing market, and studying and giving insights into that industry would lead to further growth. Running a similar study for any product will help asses the one important variable that drives that industry while you uncover details that motivate growth and acts as evidence of the transformation of the industry.

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