Understanding The Impact Of Intellectual Property In The Economy Using Statistical Models And Methods

Country Study: India

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CERTIFICATE

This is to certify that the project titled "UNDERSTANDING THE IMPACT OF INTELLECTUAL PROPERTY IN THE INDIAN ECONOMY USING STATISTICAL MODELS" is completed for the fulfilment of the Internship program as a part of M.Sc. Statistics at Osmania University, Hyderabad, Telangana carried out by Sk Israk Sahan under the supervision at Indian Institute of Social Welfare & Business Management (IISWBM), Kolkata, West Bengal, India.

31/5/2024

Prof. Dr. K M Agrawal
Director (Acting)

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ABSTRACT

This study delves into the significance of intellectual property rights (IPR) in the Indian economy using statistical models and methods. It commences by defining intellectual property and emphasising the importance of IPR in attracting foreign investment, enhancing competitiveness, and fostering domestic innovation in India. The paper then provides an overview of the legal framework for intellectual property in India, including a summary of IP laws and international agreements.

The main focus of the study is to analyse the current IP situation in India using descriptive statistics and statistical modelling. This involves examining correlations between key variables and developing linear and log-linear models to comprehend the relationships between IP, R&D,

GDP, and FDI. The study also identifies various challenges and issues in IP protection in India, such as enforcement, counterfeiting, public awareness, and the balance between IP rights and public interest.

Lastly, the paper discusses recent developments and reforms related to intellectual property in India, including government initiatives, judicial pronouncements, and the impact of technological advancements. Overall, this comprehensive analysis provides valuable insights into the role of intellectual property in driving the Indian economy.

INTELLECTUAL PROPERTY

1. INTRODUCTION

1.1. Definition of Intellectual Property

Intellectual Property (IP) refers to creations of the mind such as inventions, literary and artistic works, designs, symbols, names, and images used in commerce. It is a category of property that includes intangible creations of human intellect. IP is divided into two categories: industrial property, which includes patents, trademarks, industrial designs and geographical indications of source; and copyright, which includes literary and artistic works such as novels, poems and plays, films, musical works, artistic works such as drawings, paintings, photographs and sculptures, and architectural designs. Rights related to copyright include those of performing artists in their performances, producers of phonograms in their recordings, and broadcasters in their radio and television.

1.2. Importance of Intellectual Property Rights (IPR) in the global and Indian context

IPR protects the interests of creators by giving them property rights over their creations. This encourages innovation and creativity, fostering economic growth. In India, strong IP protection is vital for attracting foreign investment, enhancing competitiveness, and promoting domestic innovation. Patents, Industrial Designs, Trademarks and Copyrights in India are registered with the Comptroller General of Patents, Designs and Trade Marks (CGPDTM). Internationally, the Patents, Trademarks and Industrial Designs are registered with the World Intellectual Property Organization (WIPO) - a United Nations specialized agency dedicated to the promotion of innovation and creativity for the economic, social and cultural development of all countries through a balanced and effective international IP system. Established in 1967, WIPO's mandate is to promote the protection of IP worldwide through cooperation among states and in collaboration with other international organizations.

Resident Application: An application filed with an IP office by an applicant residing in the country/region in which that office has jurisdiction. For example, an application filed with the Comptroller General of Patents, Designs and Trade Marks (CGPDTM) by a resident of India is considered a resident application for the CGPDTM. Resident applications are sometimes referred to as domestic applications.

Foreign (Non-Resident) Application: An application filed with a patent office of a given country/jurisdiction by an applicant residing in another country/jurisdiction. For example, a patent application filed with the CGPDTM by an applicant residing in the USA is considered a non-resident application for the CGPDTM.

1.3. The prime aim of the present study is exploring to understand the importance of intellectual property rights in the Indian economy using statistical models.

2. Legal Framework for Intellectual Property in India

2.1. Overview of IP Laws

The Patents Act, 1970: Governs the patent system in India, providing patent rights for inventions and encouraging technological advancements.
The Trademarks Act, 1999: Regulates the registration and protection of trademarks, ensuring that brand identities are protected.
The Copyright Act, 1957: Protects the rights of authors and creators over their literary, dramatic, musical, and artistic works.
The Designs Act, 2000: Protects new and original industrial designs to encourage creativity in the design of products.
The Geographical Indications of Goods (Registration and Protection) Act, 1999: Protects products with a specific geographical origin and qualities or reputation due to that origin.
The Protection of Plant Varieties and Farmers' Rights Act, 2001: Safeguards the rights of plant breeders and farmers over new and existing plant varieties.
The Semiconductor Integrated Circuits Layout-Design Act, 2000: Protects the layout designs of semiconductor integrated circuits.

2.2. International Agreements and Conventions

1. **TRIPS Agreement (Trade-Related Aspects of Intellectual Property Rights**): India is a member of the World Trade Organization (WTO) and adheres to the TRIPS Agreement, which sets down minimum standards for many forms of IP regulation.
2. **WIPO (World Intellectual Property Organization) Treaties**: India is a signatory to several WIPO treaties, including the Berne Convention for the Protection of Literary and Artistic Works and the Paris Convention for the Protection of Industrial Property.
3. **Bilateral and Multilateral Agreements**: India has entered into various bilateral and multilateral agreements to enhance IP protection and cooperation, like
1. WIPO Internet Treaties: In July 2018, India joined the WIPO Copyright Treaty (WCT) and WIPO Performances and Phonograms Treaty (WPPT).
2. Lisbon, Nice, and Locarno Agreements: In 2019, India ratified these agreements to classify different types of IP.
3. Nice Agreement: Classifies goods and services for registering trademarks and service marks.

3. The present Economic Scenario in India

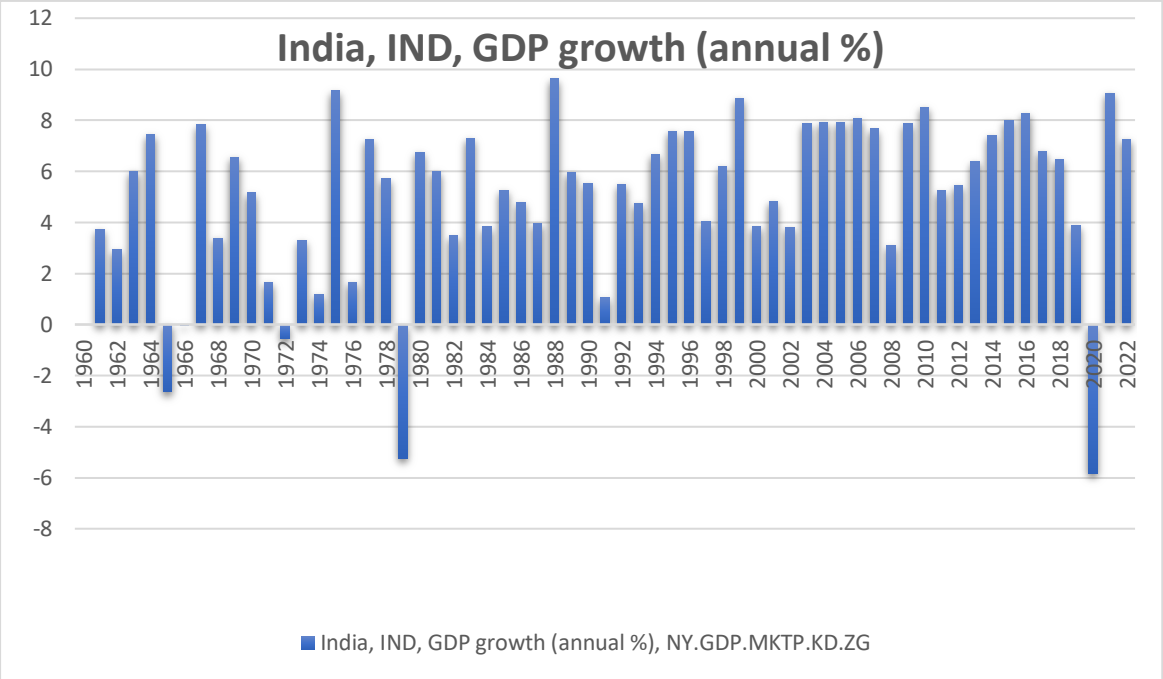
3.1. The present GDP Situation in India

India's economy is the world's fifth-largest by nominal GDP and the third-largest by Purchasing Power Parity (PPP). In the third quarter of 2024, India's GDP grew by 8.4%, which is 4.1% higher than the same quarter in 2023. This growth has led to several institutions upgrading their GDP growth forecasts for India, with Goldman Sachs raising its 2024 projection to 6.6%.

Some drivers of India's economic growth include A growing middle class, Strong domestic demand, A recovering services sector, Increasing exports of goods and services, and Foreign direct investment.
However, India also faces challenges such as High unemployment, rising income inequality, Declining aggregate demand, and Low social spending compared to OECD nations.

YEARS	India, IND, GDP growth (annual %),
1961	3.723
1962	2.931
1963	5.994
1964	7.453
1965	-2.636
1966	-0.055
1967	7.826
1968	3.388
1969	6.540
1970	5.157
1971	1.643
1972	-0.553
1973	3.296
1974	1.185
1975	9.150
1976	1.663
1977	7.255
1978	5.713
1979	-5.238
1980	6.736
1981	6.006
1982	3.476
1983	7.289
1984	3.821
1985	5.254
1986	4.777
1987	3.965
1988	9.628
1989	5.947
1990	5.533
1991	1.057
1992	5.482
1993	4.751
1994	6.659
1995	7.574
1996	7.550
1997	4.050
1998	6.184
1999	8.846
2000	3.841
2001	4.824
2002	3.804
2003	7.860
2004	7.923
2005	7.923
2006	8.061
2007	7.661
2008	3.087
2009	7.862
2010	8.498
2011	5.241
2012	5.456
2013	6.386
2014	7.410
2015	7.996
2016	8.256
2017	6.795
2018	6.454
2019	3.871
2020	-5.831
2021	9.050

2022	*7.240*

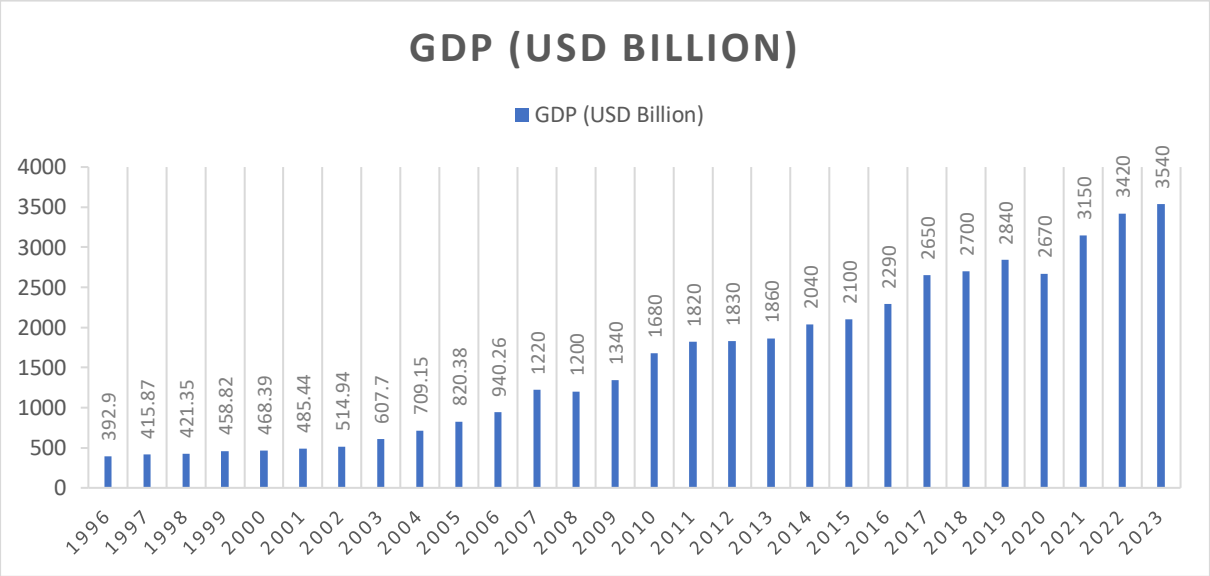


Source: WIPO

The above Table and Graphical representation represent the GDP growth rate annually from 1961 to 2022, there are a few years that show a negative growth rate (i.e. - 1965, 1966, 1972, 1979, and 2020) which are the years when India was affected by certain crises like war, drought, flood or pandemic.

Years	***GDP (USD Billion)***
1996	*392.90*
1997	*415.87*
1998	*421.35*
1999	*458.82*
2000	*468.39*
2001	*485.44*
2002	*514.94*
2003	*607.70*
2004	*709.15*
2005	*820.38*
2006	*940.26*
2007	*1220.00*
2008	*1200.00*
2009	*1340.00*
2010	*1680.00*
2011	*1820.00*
2012	*1830.00*
2013	*1860.00*
2014	*2040.00*
2015	*2100.00*
2016	*2290.00*
2017	*2650.00*
2018	*2700.00*

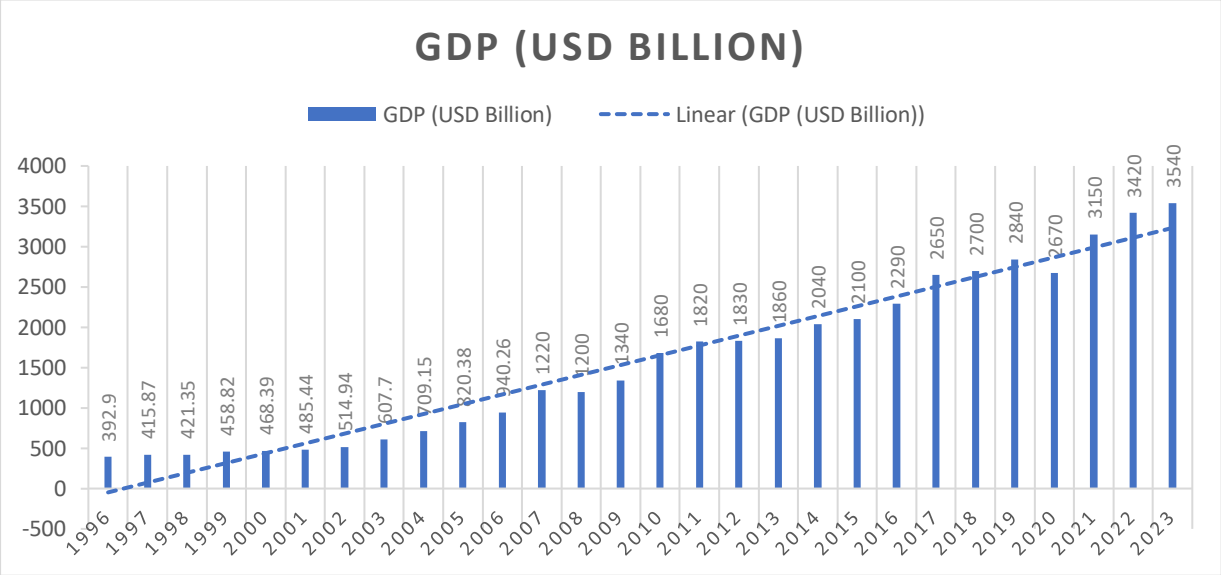
2019	*2840.00*
2020	*2670.00*
2021	*3150.00*
2022	*3420.00*
2023	*3540.00*



Source: Trading Economics

Note:

The linear Regression model is like:



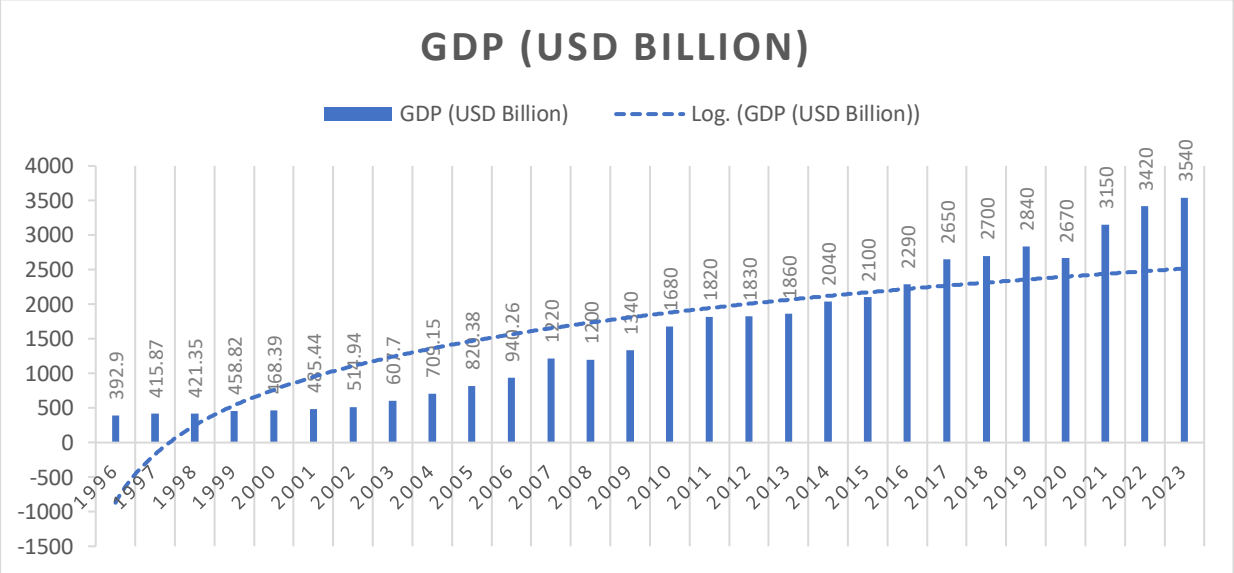
Source: Trading Economics

GDP= 121.5(YEAR) - 242494*

It's a linear equation with a slope of 0.2730 and a y-intercept of -545.9.
where: YEARS represents the year (starting from 1996 as 0, 1997 as 1, and so on).
GDP represents the GDP in USD billion. By using this linear model equation, we can predict the future trend for GDP. The predicted GDP for 2025 is 3543.5, the predicted GDP for 2026 is 3665, the predicted FDI for 2027 is 3786.5, the predicted FDI for 2028 is 3908, the predicted GDP for

2029 is 4029.5, and the predicted GDP for 2030 is 4151, but this model has a highly skewed variable which isn't suitable in a realistic scenario, so we will use the logarithmic regression model, to convert the highly skewed variable into a more normalised the skewed variable.

The Logarithmic Regression model is like:



Source: Trading Economics

*GDP=−1854275.7311+244012.3034*ln (YEARS)*

Using the logarithmic Regression model shows a significantly different and steady rise in Indian GDP, implying a steady growth of the Indian Economy. By using the logarithmic model for predicting the future trend for 2025 the predicted GDP is 3469.2337, for 2026 the predicted GDP is 3589.7039, for 2027 the predicted GDP is 3710.1146, for 2028 the predicted GDP is 3830.4659, for 2029 the predicting GDP is 3950.7579, and for 2030 the predicting GDP is 4070.9906.

3.2. The present FDI Situation in India

As of March 21, 2024, India's total FDI inflows for the financial year 2023-24 were $17.96 billion, with $11.54 billion in equity inflows. The top five countries for FDI equity inflows in 2023-24 are Mauritius (26%), Singapore (23%), USA (9%), Netherland (7%), and Japan (6%).

The top five sectors receiving the highest FDI equity inflows in 2023-24 are the services sector, Finance, Banking, Insurance, and Non-financial business.

However, FDI inflows in India declined 13% to $32.03 billion in April-December 2023, due to lower investments in the following sectors: Computer hardware and software, Telecom, Auto, and Pharma.

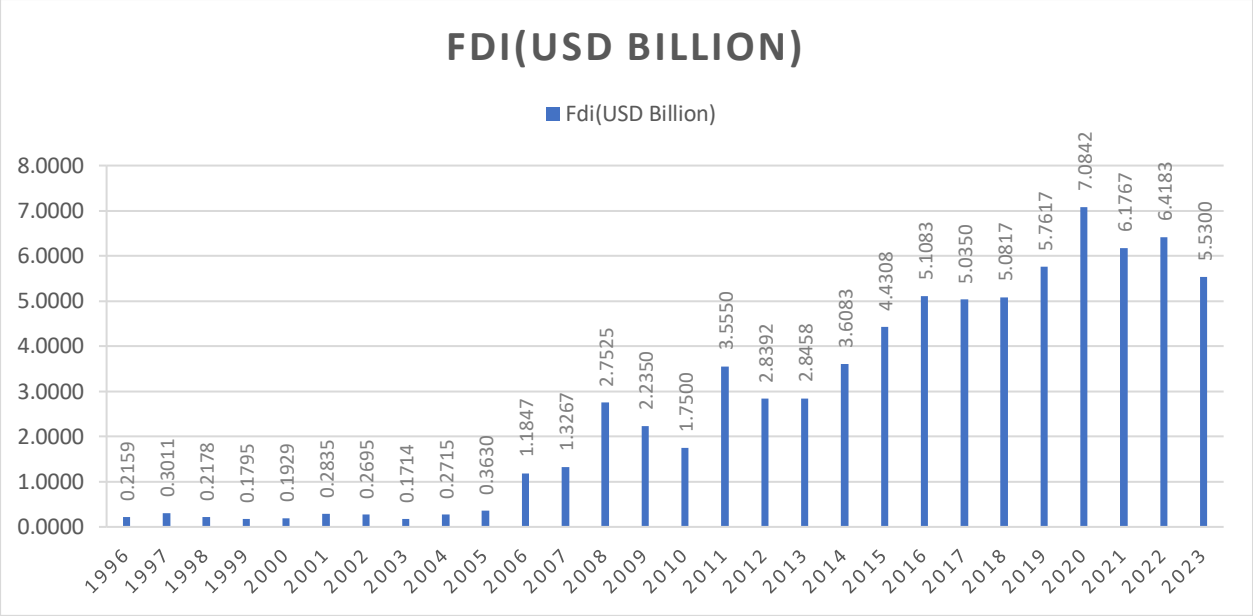
The net FDI in India was $14.55 billion from April 2023 to February 2024, down from $26.71 billion in the same period the previous year.

The government has been liberalising its FDI laws, which has helped boost FDI in India. For example, in 2021, the government removed FDI caps in the country's telecom, oil, and defence industries.

Some challenges that investors face when investing in India include:

1. Political risks, such as changes in government policies and political instability
2. Export challenges, such as customs department and export-related rules.

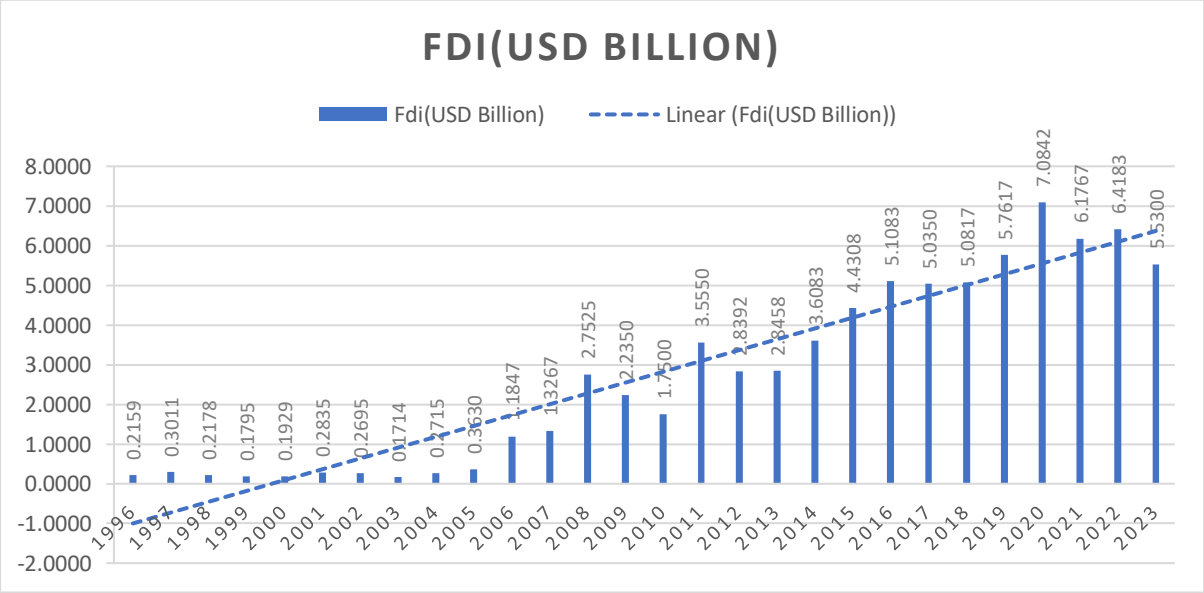
Years	FDI (USD Billion)
1996	*0.22*
1997	*0.30*
1998	*0.22*
1999	*0.18*
2000	*0.19*
2001	*0.28*
2002	*0.27*
2003	*0.17*
2004	*0.27*
2005	*0.36*
2006	*1.18*
2007	*1.33*
2008	*2.75*
2009	*2.24*
2010	*1.75*
2011	*3.56*
2012	*2.84*
2013	*2.85*
2014	*3.61*
2015	*4.43*
2016	*5.11*
2017	*5.04*
2018	*5.08*
2019	*5.76*
2020	*7.08*
2021	*6.18*
2022	*6.42*
2023	*5.53*



Source: Trading Economics

Note:

The linear Regression model is like:



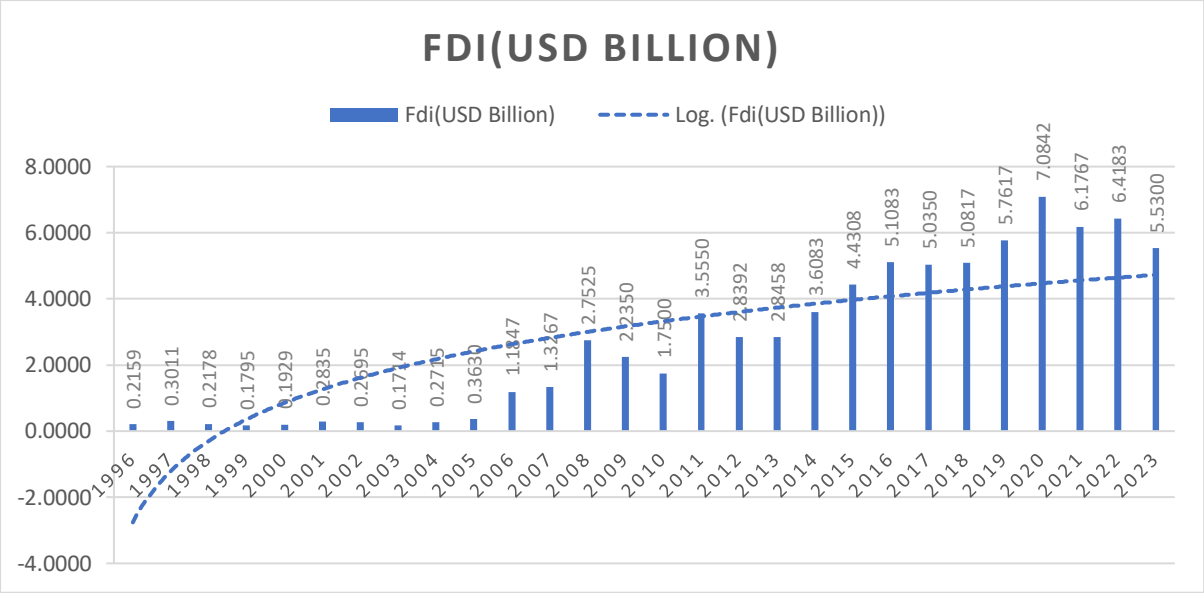
Source: Trading Economics

FDI = 0.2730(YEARS) - 545.9*

It's a linear equation with a slope of 0.2730 and a y-intercept of -545.9.
where: YEARS represents the year (starting from 1996 as 0, 1997 as 1, and so on).
FDI represents the FDI in USD billion. By using this linear model equation, we can predict the future trend for FDI. The predicted FDI for 2025 is 6.925, the predicted FDI for 2026 is 7.198, the predicted FDI for 2027 is 7.471, the predicted FDI for 2028 is 7.744, the predicting FDI for 2029 is 8.017, and the predicted FDI for 2030 is 8.29, but this model has a highly skewed

variable which isn't suitable in a realistic scenario, so we will use the logarithmic regression model, to convert the highly skewed variable into a more normalised the skewed variable.

The Logarithmic Regression model is like:



Source: Trading Economics

$$FDI = -4168.5563 + 548.4411 * \ln(YEARS)$$

Using the logarithmic Regression model shows a significantly different and steady rise in Indian FDI, implying a steady growth of the Indian Economy. And by using the logarithmic model for predicting the future trend for 2025 the predicted FDI is 6.9040, for 2026 the predicted FDI is 7.1748, for 2027 the predicted FDI is 7.4454, for 2028 the predicted FDI is 7.7159, for 2029 the predicting FDI is 7.9863, and for 2030 the predicting FDI is 8.2565.

3.3. The present R&D Situation in India

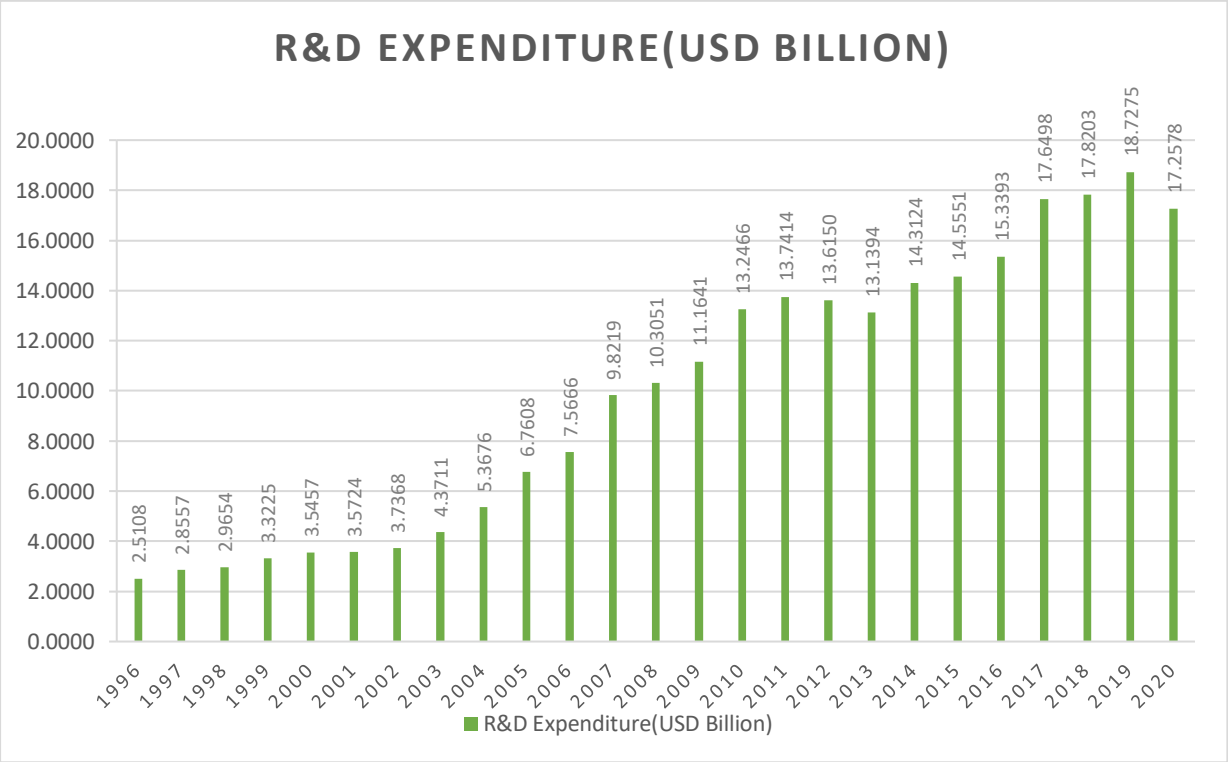
India's research and development (R&D) has been growing significantly, with a gross expenditure on R&D (GERD) of ₹12,73,810 million in 2020-21, compared to ₹6,01,968 million in 2010-11. In 2020-21, India's total R&D investment was USD 17.2 billion, with 54% of that going to the government sector. The government sector's investment is primarily used by four scientific agencies: The Defence Research and Development Organisation (DRDO) (30.7%), The Department of Space (18.4%), The Indian Council of Agricultural Research (ICAR) (12.4%), and Department of Atomic Energy (11.4%).

However, India's R&D investment as a percentage of GDP is only 0.64%, which is lower than major developed and emerging economies like China (2.4%), Germany (3.1%), South Korea (4.8%), and the United States (3.5%). The corporate sector also accounts for a smaller share of R&D in India, at 37%, compared to about two-thirds in leading economies.

India's R&D landscape includes basic, applied, and development research, with notable investments in sectors like healthcare, automotive, software and IT, and semiconductors. In 2022, India ranked third globally for research output, with over 300,000 publications. However, India's research output is still behind China (4.5 million), the United States (4.4 million), and the United Kingdom (1.4 million).

Years	R&D Expenditure (USD Billion)
1996	2.51
1997	2.86

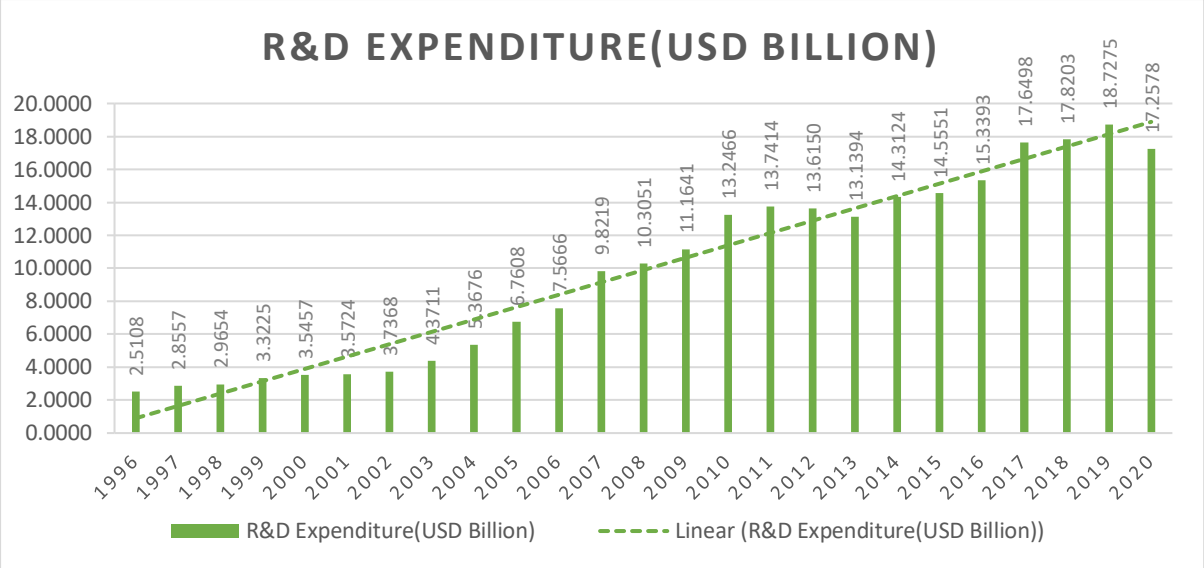
1998	2.97
1999	3.32
2000	3.55
2001	3.57
2002	3.74
2003	4.37
2004	5.37
2005	6.76
2006	7.57
2007	9.82
2008	10.31
2009	11.16
2010	13.25
2011	13.74
2012	13.62
2013	13.14
2014	14.31
2015	14.56
2016	15.34
2017	17.65
2018	17.82
2019	18.73
2020	17.26



Source: Trading Economics

NOTE:

The linear Regression model is like:

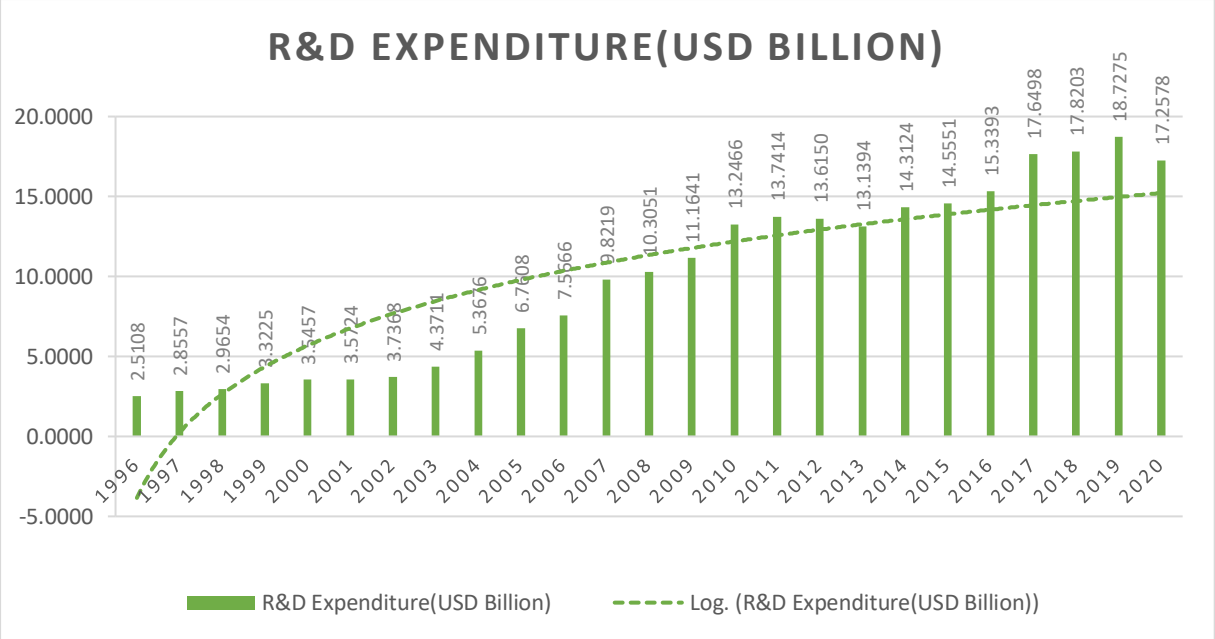


Source: Trading Economics

$$R\&D = 0.7494*(YEARS) - 1495$$

It's a linear equation with a slope of 0.7494 and a y-intercept of -1495.
where: YEARS represents the year (starting from 1996 as 0, 1997 as 1, and so on).
R&D represents the R&D Expenditure in USD billion.
*** Note: The years for R&D Expenditure are from 1996 to 2020. ***
By using this linear model equation, we can predict the future trend for R&D. The predicted R&D for 2025 is 22.535, the predicted R&D for 2026 is 23.2844, the predicted R&D for 2027 is 24.0338, the predicted R&D for 2028 is 24.7832, the predicting R&D for 2029 is 25.5326, and the predicting R&D for 2030 is 26.282, but this model has a highly skewed variable which isn't suitable in a realistic scenario, so we will used the logarithmic regression model.

The Logarithmic Regression model is like:



Source: Trading Economics

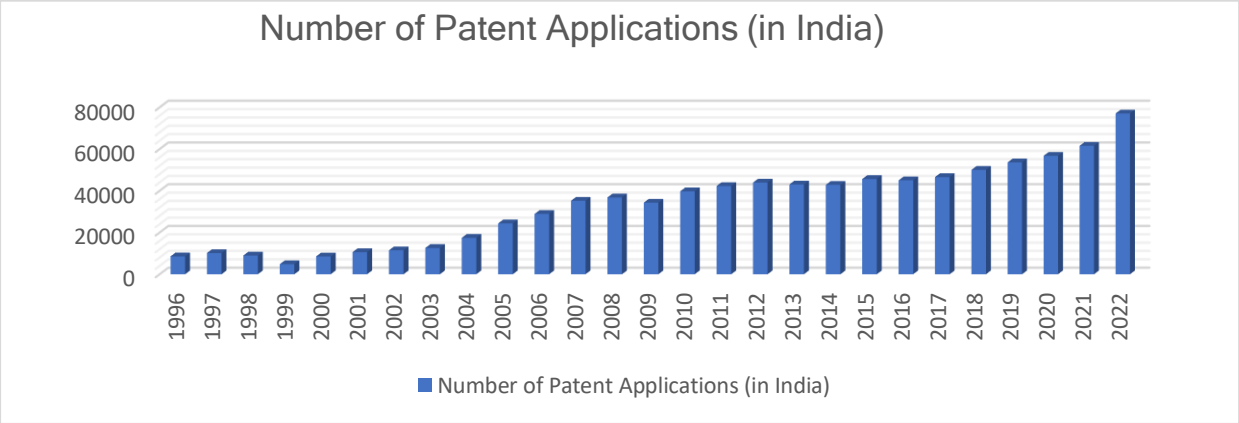
$$R\&D = -11433.1565 + 1504.6964 * \ln(YEARS)$$

Similarly, to the FDI case here in both linear and logarithmic Regression models, the models show a significantly different and steady rise in Indian R&D as years go by, also implying a steady growth of the Indian Economy. By using the logarithmic model for predicting the future trend for 2025 the predicted R&D is 22.5862, for 2026 the predicted R&D is 23.3291, for 2027 the predicted R&D is 24.0716, for 2028 the predicted R&D is 24.8137, for 2029 the predicting R&D is 25.5555, and for 2030 the predicting R&D is 26.2969.

4. Patent System in India

4.1. Definition and Types of Patents

A patent is an exclusive right granted for an invention, a product or process that provides a new way of doing something or offers a new technical solution to a problem. Types include utility patents, design patents, and plant patents. It is generally valid for 20 years, during which patent holders can commercially exploit their inventions exclusively. In return, applicants are obliged to disclose their inventions to the public in a manner that enables others to replicate the invention. The system is designed to encourage innovation by providing innovators with time-limited exclusive legal rights, thus allowing the innovators to reap the benefits of their innovative activity. Grants are exclusive IP rights conferred to an applicant by an IP office. Patents are granted to approved applicants to make use of and exploit an invention for a limited period. The holder of the rights can prevent unauthorized use of the invention.

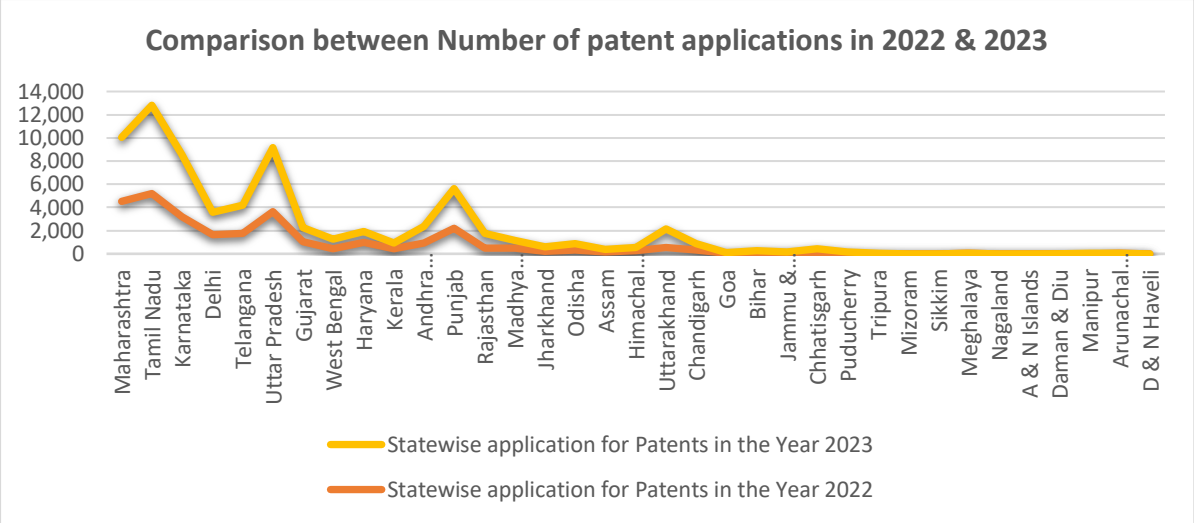


Source: CGPDTM

NOTE:

82,811 patent applications were filed with the CGPDTM in 2023, a 24.6% increase over 2022.
52% of the total patent applications filed in 2023 were by Indian residents/companies, while 48% were by foreign residents/companies.
The ratio of applications filed by Indian residents has been increasing steadily - from 25.5% of the total patent applications in 2014 to 52% in 2023.

4.2. State Wise Application for the patent in the years 2022 and 2023



Source: CGPDTM

NOTE:

44% of all patent applications made in 2022-23 were from the 3 states of Tamil Nadu, Maharashtra, and Uttar Pradesh.

The share of patent applications from residents in Maharashtra, Tamil Nadu, and Karnataka has been steadily reducing - from 57% in 2015-16 to 43% in 2022-23. This shows the slow and steady expansion of innovation hubs in other corners of India.

4.3. Patent Infringement and Enforcement

Patent infringement occurs when a patented invention is used, made, sold, or distributed without permission. Enforcement involves legal actions such as injunctions, damages, and criminal penalties.

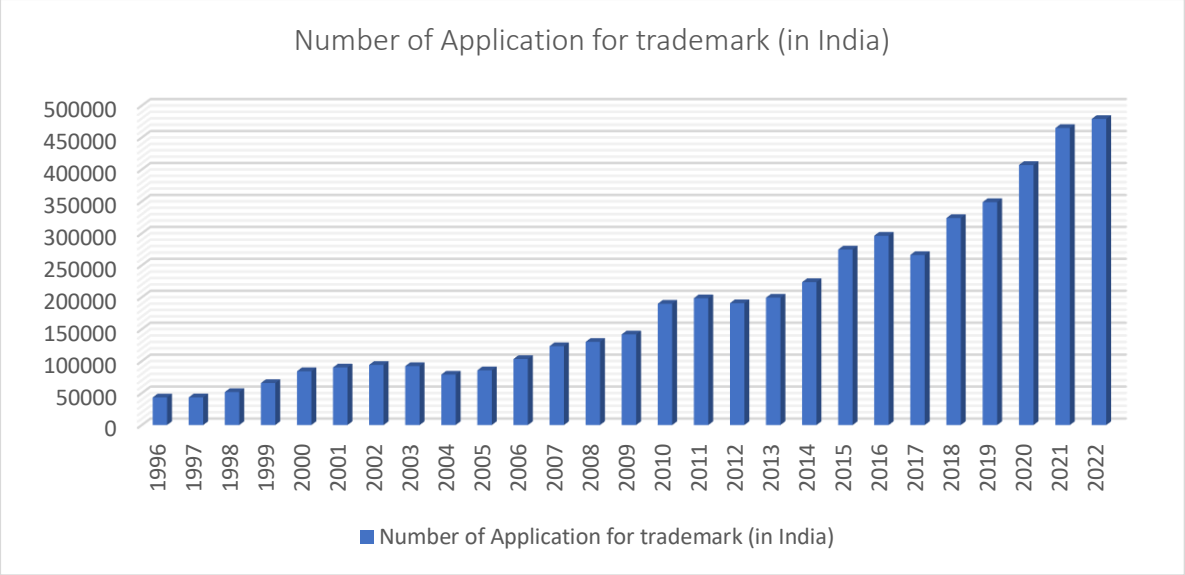
4.4. Patent Cooperation Treaty (PCT) and its role in India

The PCT allows for a single international patent application to be filed, which is then processed by various countries. India is a member, facilitating Indian inventors' access to international patent protection.

5. Trademark Protection in India

5.1. Definition and Types of Trademarks

A trademark is a sign capable of distinguishing the goods or services of one enterprise from those of other enterprises. Types include word marks, logo marks, and combination marks. The holder of a registered trademark has the legal right to exclusive use of the mark concerning the products or services for which it is registered. Unlike patents, trademark registrations can potentially be maintained indefinitely, as long as the trademark holder pays the renewal fees and uses the trademark. Registrations are exclusive rights issued to an applicant by an IP office to make use of and exploit their trademarks for commercial purposes.



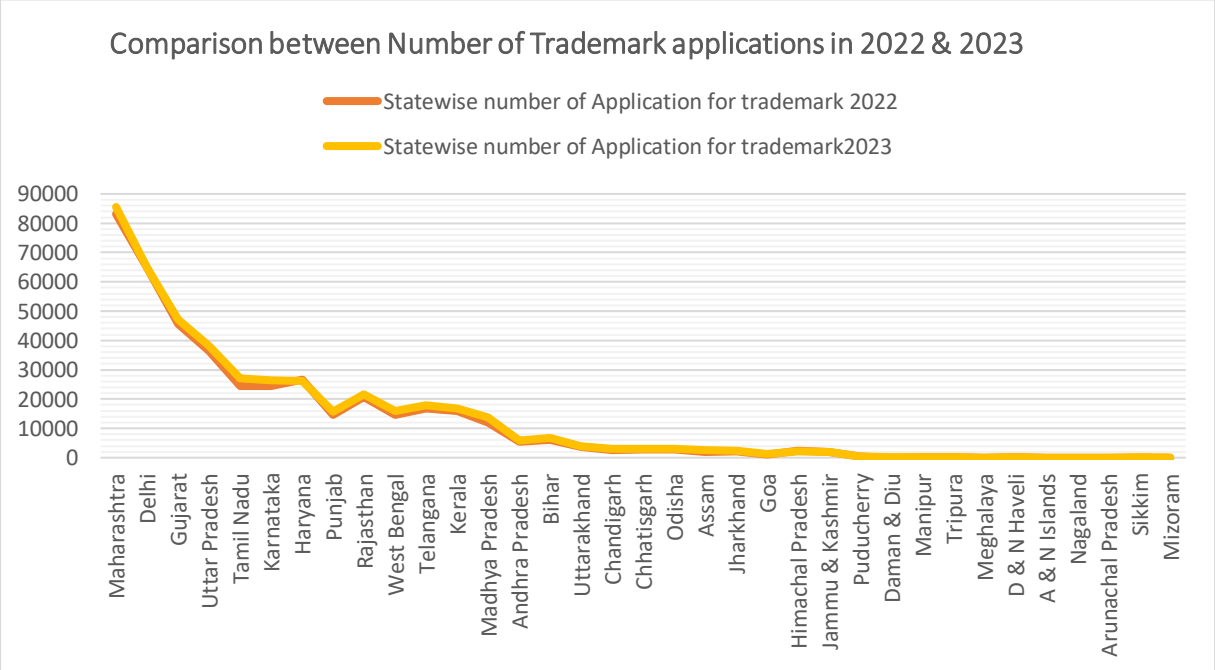
Source: CGPDTM

NOTE:

4,97,917 Trademark applications were filed with the CGPDTM in 2023, a 4.2% increase over 2022.

97% of the total trademark applications filed in 2022-23 were by Indian residents/companies, while only 3% were by foreign residents/companies. The ratio of trademark applications filed by Indian residents has been increasing steadily - from 92.1% of the total trademark applications in 2014 to 97% in 2023.

5.2. State Wise Application for the Trademark in the years 2022 and 2023



Source: CGPDTM

NOTE:

43.5% of all trademark applications made in 2022-23 were from the 3 states of Maharashtra, Delhi, and Gujarat.
The share of trademark applications from residents in Maharashtra, Delhi, and Gujarat has been steadily reducing - from 52.1% in 2016-17 to 43.5% in 2022-23. This shows the slow and steady expansion of innovation hubs in other corners of India.

5.3. Trademark Infringement and Enforcement

Trademark infringement involves the unauthorised use of a trademark. Enforcement includes legal remedies such as injunctions and damages.

5.4. Role of the Controller General of Patents, Designs and Trademarks (CGPDTM)

The CGPDTM is the head of the Indian IP office and oversees the administration of patents, trademarks, and designs in India.

6. Basic Statistical Study (Descriptive Statistics) on the Current IP Situation

Years	GDP (USD Billion)	FDI (USD Billion)	R&D Expenditure (USD Billion)	Total patent applications	Total Trademark applications	Total Industrial design applications	Total Application of the Utility Model	TOTAL APPLICATIONS FOR IP
1996	392.9	0.215916667	2.51082745	8562	43234	2357	3	54156
1997	415.87	0.301083333	2.855737703	10155	43302	2595		56052
1998	421.35	0.217833333	2.96541916 5	8954	51704	3076		63734
1999	458.82	0.1795	3.32245326 6	4826	65730	2851	2	73409
2000	468.39	0.192916667	3.54566546 1	8538	84275	3207	1	96021
2001	485.44	0.2835	3.57240150 4	10592	90236	3350	4	104182
2002	514.94	0.2695	3.73676509 8	11465	94120	3124	4	108713
2003	607.7	0.171416667	4.37112533	12613	92251	3357	9	108230
2004	709.15	0.2715	5.36755635	17466	78996	4102	1	100565
2005	820.38	0.363	6.76083361 8	24382	85669	4949	2	115002
2006	940.26	1.184666667	7.56655429 8	28928	103421	5521	3	137873
2007	1220	1.326666667	9.821854	35218	123514	6402	8	165142
2008	1200	2.7525	10.30512	36812	130172	6557	19	173560
2009	1340	2.235	11.164076	34287	141943	6092	25	182347
2010	1680	1.75	13.246632	39762	189926	7038	36	236762
2011	1820	3.555	13.741364	42291	198547	8216	32	249086
2012	1830	2.839166667	13.615017	43955	190850	8545	15	243365
2013	1860	2.845833333	13.139412	43031	199456	8497	50	251034
2014	2040	3.608333333	14.312436	42854	223756	9309	43	275962
2015	2100	4.430833333	14.5551	45658	274825	10290	34	330807
2016	2290	5.108333333	15.339336	45057	296322	10673	24	352076
2017	2650	5.035	17.649795	46582	266170	11117	34	323903
2018	2700	5.081666667	17.82027	50055	324016	12632	34	386737
2019	2840	5.761666667	18.727528	53627	348948	13723	36	416334
2020	2670	7.084166667	17.257812	56771	407034	12793	513	477111
2021	3150	6.176666667		61573	464958	21446	2371	550348
2022	3420	6.418333333		77068	479187	22557	675	579487
2023	3540	5.53						

The average GDP from 1996 to 2023: 1,592.329
The average FDI from 1996 to 2023: 2.686
The average R&D from 1996 to 2020: 9.891
The average Patent Applications from 1996 to 2022: 33,373.407
The average Trademark Applications from 1996 to 2022: 1,88,613.407
The average IP Applications from 1996 to 2022: 2,30,074

These averages are the mean of all the variables for the given period as per the data. It represents how much of the variable can expected, well even though the actual value can be a bit higher or lower than these written mean variables depending on the situation of the period.

The variance in GDP from 1996 to 2023: 10,37,447.84
The variance in FDI from 1996 to 2023: 5.539
The variance in R&D from 1996 to 2020: 31.583
The variance in Patent Applications from 1996 to 2022: 37,69,28,733.9
The variance in Trademark Applications from 1996 to 2022: 16,67,81,41,404
The variance in IP Applications from 1996 to 2022: 23,34,35,31,585

These variances represent the square of the spread-out length from their average values of the variables.

The Standard Deviation in GDP from 1996 to 2023: 1,018.552
The Standard Deviation in FDI from 1996 to 2023:2.354
The Standard Deviation in R&D from 1996 to 2020: 5.62
The Standard Deviation in Patent Applications from 1996 to 2022: 19,414.653
The Standard Deviation in Trademark Applications from 1996 to 2022: 1,29,143.879
The Standard Deviation in IP Applications from 1996 to 2022: 1,52,785.901

These Standard Deviations represent the spread-out length from their average values of the variables.

7. Statistical Models on IP:

7.1. CORRELATIONS BETWEEN THE MODEL VARIABLES:

	GDP(USD Billion)	FDI(USD Billion)	R&D Expenditure	Total patent applications	Total Trademark applications	Total Industrial design applications	Total Application of Utility Model	TOTAL Applications for IP
GDP(USD Billion)	1	0.9614491	0.9888699	0.9522561	0.9594894	0.9904285	0.4326708	0.9720933
FDI(USD Billion)	0.9614491	1	0.9380006	0.9134092	0.9739185	0.9693711	0.56878	0.9785271
R&D Expenditure (USD Billion)	0.9888699	0.9380006	1	0.9784173	0.9253645	0.9748696	0.3916197	0.9462534
Total patent applications	0.9522561	0.9134092	0.9784173	1	0.8920905	0.9498899	0.4390054	0.9203114
Total Trademark applications	0.9594894	0.9739185	0.9253645	0.8920905	1	0.9696959	0.5928157	0.9977514
Total Industrial design applications	0.9904285	0.9693711	0.9748696	0.9498899	0.9696959	1	0.4573634	0.9807203
Total Application of Utility Model	0.4326708	0.56878	0.3916197	0.4390054	0.5928157	0.4573634	1	0.5763638
TOTAL Applications for IP	0.9720933	0.9785271	0.9462534	0.9203114	0.9977514	0.9807203	0.5763638	1

NOTE:

This correlation table shows how much the variables are dependent on the other variables as it represents that if a certain variable has an increase or a decrease all the other variables will be affected as per the correlation or close to it, the higher correlations are presented with the yellow(>0.975), the variables lower than that are represented by the orange((0.5- 0.975), whereas the variable lower than 0.5 are represented by blue.

7.2. Linear Models and Log-linear models

Why should we use the linear and log-linear models in these scenarios?

The linear model helps us establish the relationship between the various variables, which is needed to determine whether the same variable has any impact on the future of the explained variable, or could the explanatory variable be used to improve the explained variable.

In the case of the log-linear model, we use it to make the calculation easier, as the log-linear model is a convenient means of transforming a highly skewed variable linear model into a more normalised and moderately skewed variable, Log-linear models are only used when a linear model is highly skewed. In theory, we want to produce the smallest error possible when making a prediction, while also considering that we should not be overfitting the model. Overfitting occurs when there are too many dependent variables in play that it does not have enough generalisation of the dataset to make a valid prediction. Using the logarithm of one or more variables improves the fit of the model by transforming the distribution of the features to a more normally shaped bell curve.

7.2.1. Linear Model for Patent:

Model: (Patent application) = nA + γ1*(R&D) + γ2*(GDP) + γ3*(FDI) + index + ε

Patent application is the number of patent applications per year,

R&D is the national R&D expenditure per year,

GDP is the gross domestic production per year,

FDI is the foreign direct investment capital per year,

index is a dummy variable that represents an improvement of the IPR regime in India which comes from the Ginarte and Park IP Index for every year,

nA is a coefficient that captures all other variables not explicitly represented in the model.

MODEL:

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	1810.903	1530.917	1.183	0.25007	
a$R.D.Expenditure.USD.Billion.	5443.011	746.627	7.290	3.53e-07	***
a$Fdi.USD.Billion.	2158.182	1042.866	2.069	0.05103	.
a$GDP..USD.Billion.	-21.810	6.277	-3.474	0.00226	**

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

Residual standard error: 2770 on 21 degrees of freedom
(3 observations deleted due to missingness)
Multiple R-squared: 0.9766, Adjusted R-squared: 0.9733

F-statistic: 292.3 on 3 and 21 DF, p-value: < 2.2e-16

This shows that there's a significant difference in the R&D and GDP fields which represent the growth of India in these fields in recent years.

The number of observations is 26, and the linear equation that is formed from the known variables is:

"(Patent application) = 5443.011*(R&D) + 2158.182*(FDI) - 21.810*(GDP) + 1810.903"

From the data table we have, we find out that:

If the GDP is increased by 10% then the number of patent applications grows by 12.37%,

If the FDI is increased by 10% then the number of patent applications grows by 5.18%,

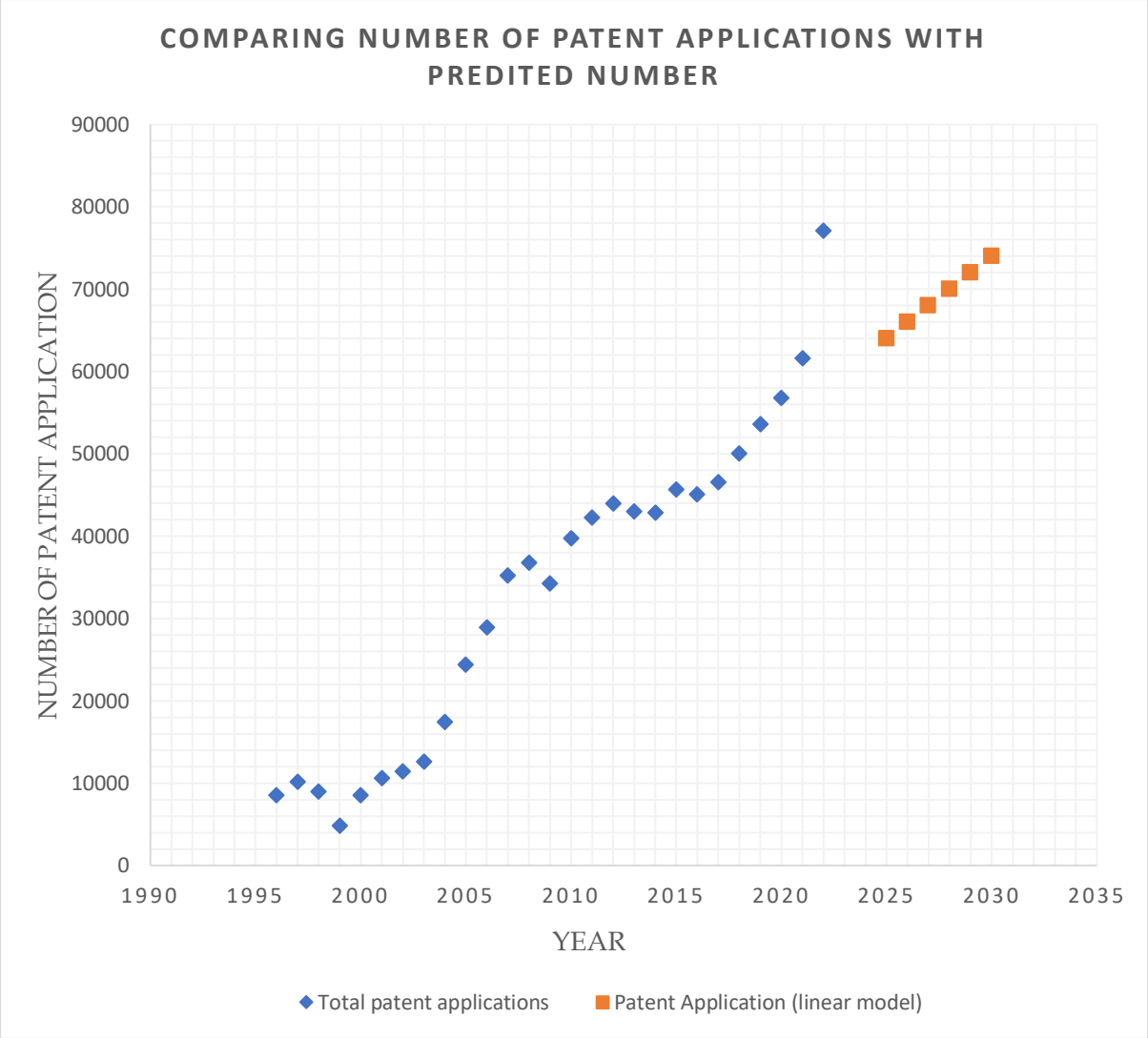
If the R&D is increased by 10% then the number of patent applications grows by 12.44%

The model used in estimating the future application.

Now we will use the previously predicted R&D, GDP & FDI values from the log-linear models to find the number of patent applications in 2025, 2026, 2027, 2028, 2029, and 2030.

By using the above equation, we find that:

the number of predicted patent applications in 2025 is 63983.9396;
the number of predicted patent applications in 2026 is 65984.53307;
the number of predicted patent applications in 2027 is 67983.81542;
the number of predicted patent applications in 2028 is 69982.00027;
the number of predicted patent applications in 2029 is 71979.62972;
and the number of predicted patent applications in 2030 is 73975.94366.



7.2.2. Log-Linear Model for Patent:

Model: ln (Patent application) = nA + γ1*ln(R&D) + γ2*ln(GDP) + γ3*ln(FDI) + index + ε

Patent application is the number of patent applications per year,

R&D is the national R&D expenditure per year,

GDP is the gross domestic production per year,

FDI is the foreign direct investment capital per year,

index is a dummy variable that represents an improvement of the IPR regime in India which comes from the Ginarte and Park IP Index for every year,

nA is a coefficient that captures all other variables not explicitly represented in the model.

MODEL:

Coefficients:

Estimate Std. Error t value Pr(>|t|)

```
(Intercept)                    12.3036     2.5821   4.765 0.000105 ***
log(a$R.D.Expenditure.USD.Billion.)   1.5306     0.4540   3.371 0.002888 **
log(a$Fdi.USD.Billion.)             0.1531     0.1089   1.406 0.174249
log(a$GDP..USD.Billion.)           -0.7722     0.4864  -1.588 0.127329
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.1825 on 21 degrees of freedom
  (3 observations deleted due to missingness)
Multiple R-squared:  0.9479,       Adjusted R-squared:  0.9405
F-statistic: 127.4 on 3 and 21 DF,  p-value: 1.24e-13
```

This shows that there's a significant difference in the R&D fields which represent the growth of India in these fields in recent years.

The number of observations is 26, and the linear equation that is formed from the known variables is:

"***ln(Patent application)= 1.5306*ln(R&D)+0.1531*ln(FDI)-0.7722*ln(GDP)***"

7.2.3. Linear Model for Trademark:

Model: (Trademark application) = nA + γ1*(R&D) + γ2*(GDP) + γ3*(FDI) + index + ε

Patent application is the number of patent applications per year,

R&D is the national R&D expenditure per year,

GDP is the gross domestic production per year,

FDI is the foreign direct investment capital per year,

index is a dummy variable that represents an improvement of the IPR regime in India which comes from the Ginarte and Park IP Index for every year,

nA is a coefficient that captures all other variables not explicitly represented in the model.

MODEL:

```
Coefficients:
                                Estimate Std. Error t value Pr(>|t|)
(Intercept)                    40184.27   11404.09   3.524  0.00202 **
a$R.D.Expenditure.USD.Billion. -11650.46    5561.76  -2.095  0.04850 *
a$Fdi.USD.Billion.             25005.13    7768.51   3.219  0.00412 **
a$GDP..USD.Billion.              133.36      46.76   2.852  0.00954 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Residual standard error: 20630 on 21 degrees of freedom
(3 observations deleted due to missingness)
Multiple R-squared: 0.9656, Adjusted R-squared: 0.9607
F-statistic: 196.5 on 3 and 21 DF, p-value: 1.6e-15

This shows that there's a significant difference in the R&D, FDI and GDP fields which represent the growth of India in these fields in recent years.

The number of observations is 26, and the linear equation that is formed from the known variables is:

"***Trademark application = 25005.13*(FDI) -11650.46*(R&D) +133.36(GDP)+40184.27***"

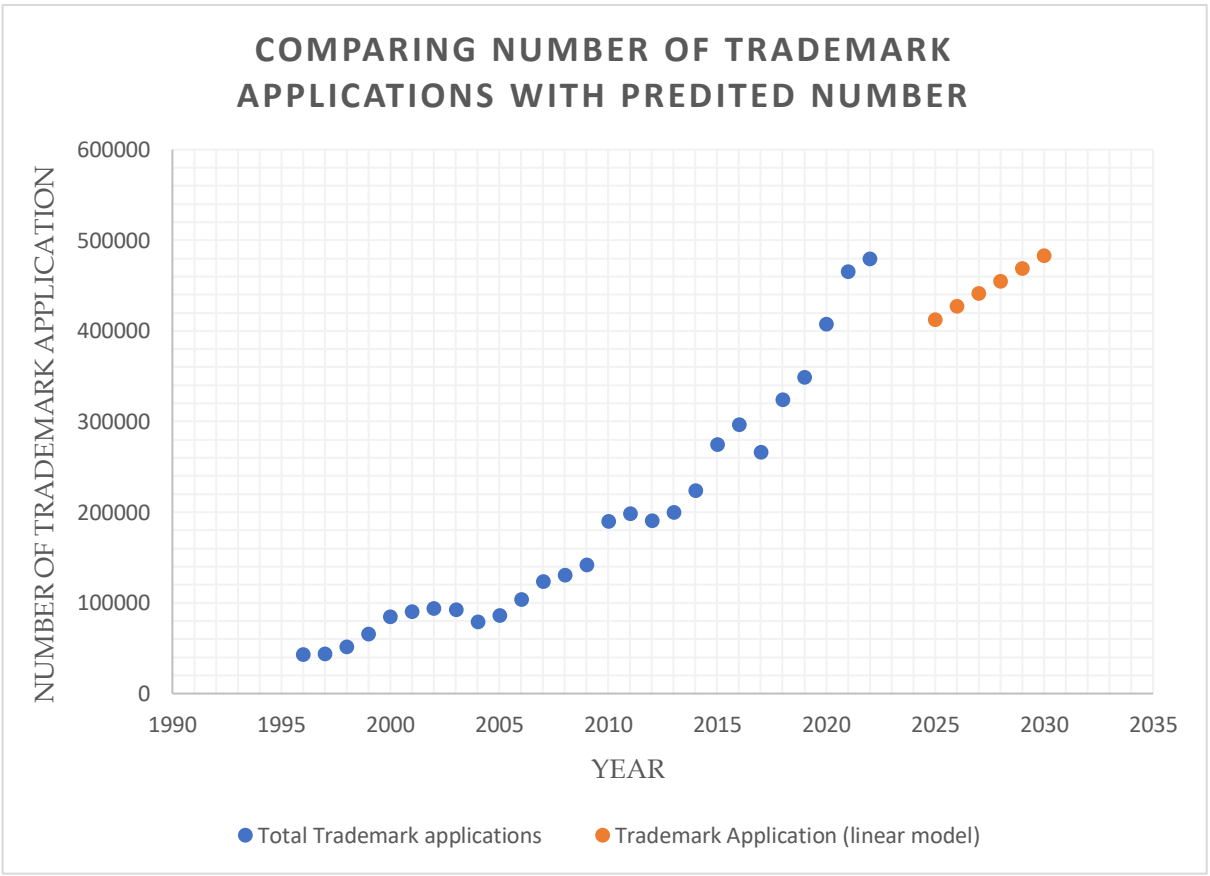
From the data table we have, we find out that:

If the GDP is increased by 10% then the number of Trademark applications grows by 4.92%,
If the FDI is increased by 10% then the number of Trademark applications grows by 11.8%,
If the R&D is increased by 10% then the number of Trademark applications grows by 9.17%

The model used in estimating the future application.

Now we will use the previously predicted R&D, GDP & FDI values from the log-linear models to find the number of trademark applications in 2025, 2026, 2027, 2028, 2029, and 2030.

By using the above equation, we find that the number of predicted trademark applications in 2025 is 412337.0741; the number of predicted trademark applications in 2026 is 427040.018; the number of predicted trademark applications in 2027 is 441333.2663; the number of predicted trademark applications in 2028 is 454861.2657; the number of predicted trademark applications in 2029 is 469022.4827; and the number of predicted trademark applications in 2030 is 483175.4507.



7.2.4. Log-Linear Model for Trademark:

Model: ln (Trademark application) = nA + γ1*ln(R&D) + γ2*ln(GDP) + γ3*ln(FDI) + index + ε

Patent application is the number of patent applications per year,

R&D is the national R&D expenditure per year,

GDP is the gross domestic production per year,

FDI is the foreign direct investment capital per year,

index is a dummy variable that represents an improvement of the IPR regime in India which comes from the Ginarte and Park IP Index for every year,

nA is a coefficient that captures all other variables not explicitly represented in the model.

MODEL:

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	1.64242	2.56969	0.639	0.52963	
log(a$R.D.Expenditure.USD.Billion.)	-0.60988	0.45185	-1.350	0.19147	
log(a$Fdi.USD.Billion.)	-0.07127	0.10837	-0.658	0.51789	
log(a$GDP..USD.Billion.)	1.63458	0.48409	3.377	0.00285	**

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1816 on 21 degrees of freedom
(3 observations deleted due to missingness)
Multiple R-squared: 0.9342, Adjusted R-squared: 0.9248
F-statistic: 99.4 on 3 and 21 DF, p-value: 1.429e-12

This shows that there's a significant difference in the GDP fields which represent the growth of India in these fields in recent years.

The number of observations is 26, and the linear equation that is formed from the known variables is:

"***ln(Trademark)=1.63458*ln(GDP)-0.60988*ln(R&D)-0.07127*ln(FDI)+1.64242***"

7.2.5. Linear Model for IP:

Model: (Total IP application) = nA + γ1*(R&D) + γ2*(GDP) + γ3*(FDI) + index + ε

Patent application is the number of patent applications per year,

R&D is the national R&D expenditure per year,

GDP is the gross domestic production per year,

FDI is the foreign direct investment capital per year,

index is a dummy variable that represents an improvement of the IPR regime in India which comes from the Ginarte and Park IP Index for every year,

nA is a coefficient that captures all other variables not explicitly represented in the model.

MODEL:

```
Coefficients:
                                  Estimate Std. Error t value Pr(>|t|)
(Intercept)                       43519.14   11889.88   3.660  0.00146 **
a$R.D.Expenditure.USD.Billion. -6257.31    5798.68  -1.079  0.29279
a$Fdi.USD.Billion.                27594.03    8099.43   3.407  0.00265 **
a$GDP..USD.Billion.                 115.06      48.75   2.360  0.02802 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 21510 on 21 degrees of freedom
  (3 observations deleted due to missingness)
Multiple R-squared:  0.9733,       Adjusted R-squared:  0.9695
F-statistic: 255.4 on 3 and 21 DF,  p-value: < 2.2e-16
```

This shows that there’s a significant difference in the R&D, FDI and GDP fields which represent the growth of India in these fields in recent years.

The number of observations is 26, and the linear equation that is formed from the known variables is:

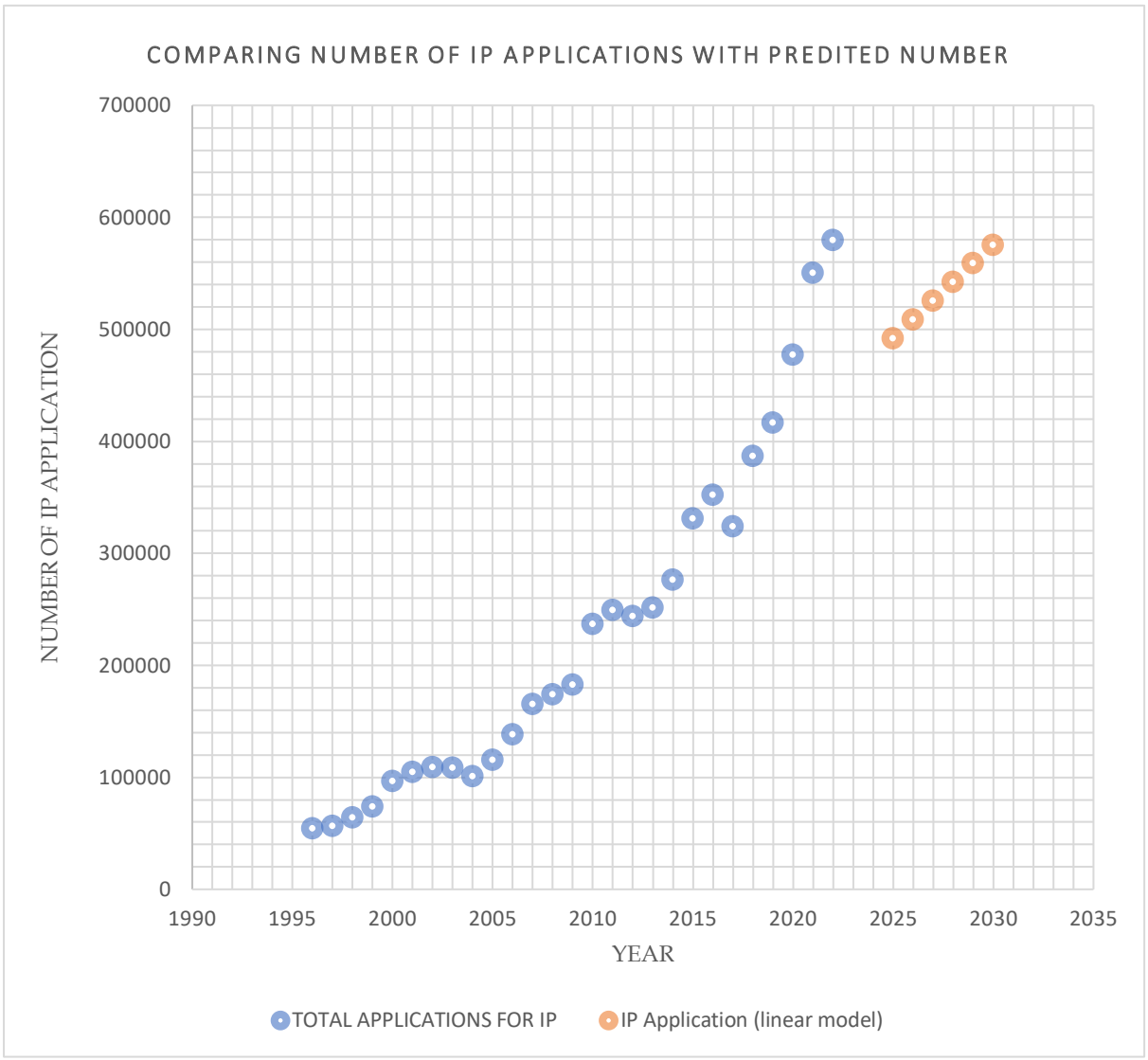
“***IP = 27594.03(FDI)-6257.31(R&D) +115.06(GDP)+43519.14***”

If the GDP is increased by 10% then the number of Trademark applications grows by 12.44%,
If the FDI is increased by 10% then the number of Trademark applications grows by 9.49%,
If the R&D is increased by 10% then the number of Trademark applications grows by 9.67%

The model used in estimating the future application.

Now we will use the previously predicted R&D, GDP & FDI values from the log-linear models to find the number of IP applications in 2025, 2026, 2027, 2028, 2029, and 2030.

By using the above equation, we find that the number of predicted IP applications in 2025 is 491869.4975; the number of predicted IP applications in 2026 is 508554.7065; the number of predicted IP applications in 2027 is 525230.0534; the number of predicted IP applications in 2028 is 541898.3094; the number of predicted IP applications in 2029 is 558558.8601; and the number of predicted IP applications in 2030 is 575209.5718.



7.2.6. Log-Linear Model for IP:

Model: ln (Total IP application) = nA + γ1*ln(R&D) + γ2*ln(GDP) + γ3*ln(FDI) + index + ε

Patent application is the number of patent applications per year,

R&D is the national R&D expenditure per year,

GDP is the gross domestic production per year,

FDI is the foreign direct investment capital per year,

index is a dummy variable that represents an improvement of the IPR regime in India which comes from the Ginarte and Park IP Index for every year,

nA is a coefficient that captures all other variables not explicitly represented in the model.

MODEL:

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	4.02156	2.04955	1.962	0.06313	.
log(a$R.D.Expenditure.USD.Billion.)	-0.24303	0.36039	-0.674	0.50745	

```
log(a$Fdi.USD.Billion.)          -0.03566    0.08643  -0.413  0.68408
log(a$GDP..USD.Billion.)          1.21513    0.38611   3.147  0.00486 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.1448 on 21 degrees of freedom
  (3 observations deleted due to missingness)
Multiple R-squared:  0.9574,      Adjusted R-squared:  0.9514
F-statistic: 157.5 on 3 and 21 DF,  p-value: 1.49e-14
```

This shows that there's a significant difference in the GDP fields which represent the growth of India in these fields in recent years.

The number of observations is 26, and the linear equation that is formed from the known variables is:

"***ln(IP) = 1.21513*ln(GDP)-0.24303*ln(R&D)-0.03566*ln(FDI)+4.02156***"

8. Challenges and Issues in IP Protection in India

8.1. Enforcement Issues

Enforcing IP rights in India can be challenging due to a lack of resources, judicial delays, and the need for better coordination between enforcement agencies.

8.2. Counterfeiting and Piracy

Counterfeiting and piracy are major issues, affecting industries such as pharmaceuticals, entertainment, and consumer goods.

8.3. Public Awareness and Education

There is a need for greater public awareness and education about IP rights to ensure creators and businesses can protect and enforce their rights effectively.

8.4. Backlog and Delays in IP Registrations

The IP offices in India face significant backlogs and delays, which can hinder the timely grant of IP rights.

8.5. Balancing IP Rights with Public Interest (e.g., Access to Medicines)

Balancing the rights of IP holders with public interest, such as ensuring access to affordable medicines, is a critical issue in India.

9. Recent Developments and Reforms

9.1. Government Initiatives and Policies

National IPR Policy: Launched in 2016, this policy aims to modernise the IP infrastructure, increase IP awareness, and strengthen enforcement mechanisms.

Make in India and Startup India Programs: These initiatives promote innovation and encourage the creation and protection of IP.

9.2. Judicial Pronouncements and Landmark Cases

Recent judicial decisions have clarified and strengthened IP laws, including rulings on software patents, pharmaceutical patents, and trademark disputes.

9.3. Technological Advancements and their Impact on IP

Advancements in technology, such as AI and blockchain, are influencing IP practices and enforcement, offering new tools and posing new challenges.

10. Conclusion

The analysis of intellectual property (IP) in India underscores its critical importance in fostering innovation, economic growth, and competitive advantage both domestically and globally. Several key insights emerged from this study:

Steady Growth in IP Applications: The consistent increase in patent and trademark applications in India highlights the growing recognition and importance of IP protection among Indian enterprises and individuals. The data indicates a significant rise in applications by Indian residents, showcasing domestic innovation and the strategic use of IP rights.

82,811 patent applications were filed in 2023, a 24.6% increase over 2022. 52% of the total patent applications filed in 2023 were by Indian residents/companies, while 48% were by foreign residents/companies. The ratio of applications filed by Indian residents has been increasing steadily - from 25.5% of the total patent applications in 2014 to 52% in 2023.

4,97,917 Trademark applications were filed in 2023, a 4.2% increase over 2022. 97% of the total trademark applications filed in 2023 were by Indian residents/companies, while only 3% were by foreign residents/companies. The ratio of trademark applications filed by Indian residents has been increasing steadily - from 92.1% of the total trademark applications in 2014 to 97% in 2023. All these factors showcase the growth of India in the field of IP, which led to the growth of the Indian economy and development sectors.

Factors behind the Growth in IP Applications and the relationship between them: There are many factors behind the growth of IP Applications, such as the steady growth of GDP, FDI, and R&D. The growth of FDI per year and the growth of R&D expenditure per year can be expressed in the form of equations:

a) FDI = 0.2730 * (YEARS)- 545.9 & FDI =- 4168.5563 + 548.4411 * ln (YEARS)

b) R&D = 0.7494 * (YEARS)- 1495 & R&D =- 11433.1565 + 1504.6964 * ln (YEARS)

Whereas, the GDP generally shows positive growth (annual %) except for the years 1965, 1966, 1972, 1979, and 2020, when India was affected by certain crises like war, drought, flood or pandemic.

The relationship between the IP and the above factor can be expressed by using linear models and log-linear models:

IP = 27594.03 * (FDI) - 6257.31 * (R&D) + 115.06 * (GDP) + 43519.14 +index; &

Ln (IP) = 1.21513*ln (GDP) - 0.24303 * ln (R&D) - 0.03566 * ln (FDI) + 4.02156 + index

Regional Expansion: While significant contributions come from traditional innovation hubs like Maharashtra, Tamil Nadu, Delhi, and Gujarat, the reduction in their share of total applications points to the gradual development of other regional centres. This geographic diversification is a positive indicator of positively indicates wider national engagement with IP and innovation.

44% of all patent applications made in 2023 were from the 3 states of Tamil Nadu, Maharashtra, and Uttar Pradesh. The share of patent applications from residents in

Maharashtra, Tamil Nadu, and Karnataka has been steadily reducing - from 57% in 2016 to 43% in 2023.
43.5% of all trademark applications made in 2023 were from the 3 states of Maharashtra, Delhi, and Gujarat. The share of trademark applications from residents in Maharashtra, Delhi, and Gujarat has been steadily reducing - from 52.1% in 2017 to 43.5% in 2023. This shows the slow and steady expansion of innovation hubs in other corners of India

Challenges in IP Enforcement: Despite the growth, the effective enforcement of IP rights remains a challenge. Issues such as judicial delays, resource scarcity, counterfeiting, and piracy need ongoing attention. Strengthening the legal and administrative frameworks to address these challenges is crucial for sustaining IP-driven economic progress.

Government Initiatives and Reforms: Initiatives like the National IPR Policy, make in India, and Startup India have created a conducive environment for IP protection and innovation. These policies, along with recent technological advancements in enforcement mechanisms, are vital steps towards robust IP infrastructure.

International Engagement: India's active participation in international IP treaties and conventions, such as the TRIPS Agreement and various WIPO treaties, underscores its commitment to global standards of IP protection. These engagements not only enhance cross-border IP cooperation but also support Indian inventors in accessing international markets.

In conclusion, the current state of intellectual property in India reflects a landscape of vigorous growth and dynamic innovation. Continued focus on enhancing IP awareness, expediting administrative processes, and robustly enforcing IP rights will be pivotal in leveraging IP as a tool for sustained economic development and global competitiveness.

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