Some Facts About Indian Innovation in the Twenty-First Century

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India Policy Forum

Motivation

Innovation key driver of economic growth and development

- The world's seven largest private companies (by market capitalization) as of December 2020 all produce products that had not been invented fifty years earlier (Bryan and Williams, 2021)*

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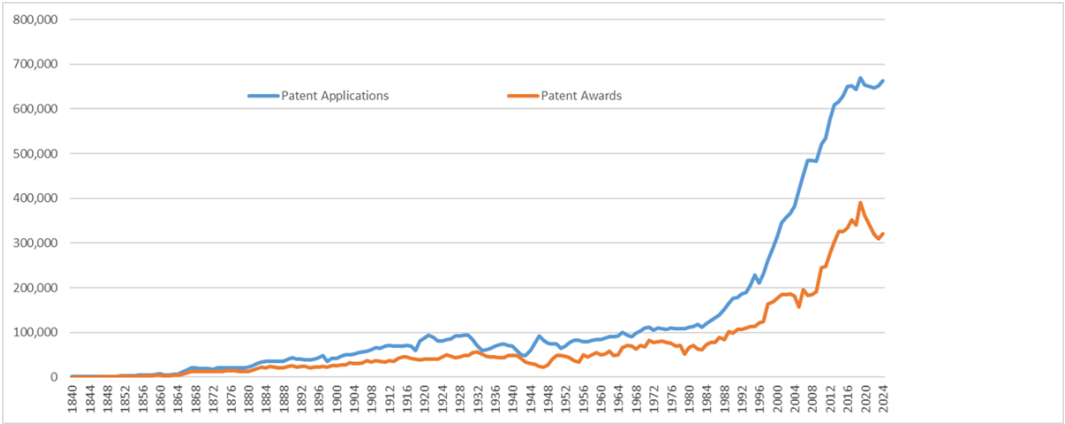
- Strong correlation between R&D spending and GDP per capita (World Bank, 2023)
- R&D activity in developing countries rising rapidly

⇒ **Understanding the determinants of and returns to innovation important for development policy**

*Microsoft, Apple, Amazon, Alphabet (Google), Alibaba, Facebook, and Tencent (Wechat)

Innovation Rising in the US...

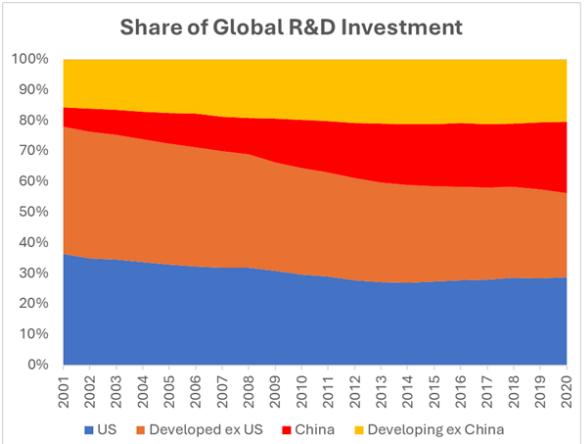
US Patenting Trends

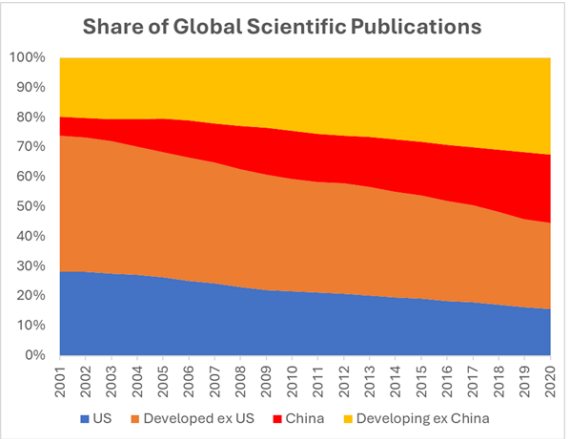


Note: Sources: U.S. Patent and Trademark Office,

AND, Innovative Activity Increasing in Emerging Markets

Global Changes in Innovative Activity: R&D and Scientific Publications





Recent Innovation Resource Allocation in India

- R&D expenditures climbed six times over in U.S.D terms between 1990-91 and 2020-21 (Department of Science and Technology, Ministry of Science and Technology, Government of India, 2023).

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How does innovation output and quality track these trends?

This Project

Combine several sources of data to understand Indian innovation, its determinants and its returns.

Today, drawing on a technical working paper, and Kala, Lerner and Liu (2024),

- Highlight significant gaps in commonly used international data sources for studying Indian innovation (WIPO and PatStat)

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- Document data collection and processing analogous to that pursued with U.S. patent data since (Griliches, 1984) (But: how innovation can be ascertained may vary across contexts)
- Showcase seven stylized facts about recent Indian innovation (2005-2018)

Planned future dataset: all patents cleaned and pre-processed 1970-2023

Overview of Data Collection and Processing

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  - Disambiguation of names, and merging with CMIE's Prowessdx database (firm panel with firm identifiers) and (now) Pitchbook
- To focus on localized Indian innovation, create a specific Indian patent dataset by including the following patents of either of the following types: (1) patents with at least one assignee whose address is in India; and (2) patents with at least one inventor whose address is in India. We identify 67,369 Indian patents using this definition.

Paper appendices include detailed description of these data collection pipelines.

1. Motivation
2. Gaps in Common Data Sources
3. Stylized Facts
   - Aggregate Trends
   - Stability of Geographical Distribution of Innovation
   - Top Contributors to Innovation by Patent Numbers and Their Composition
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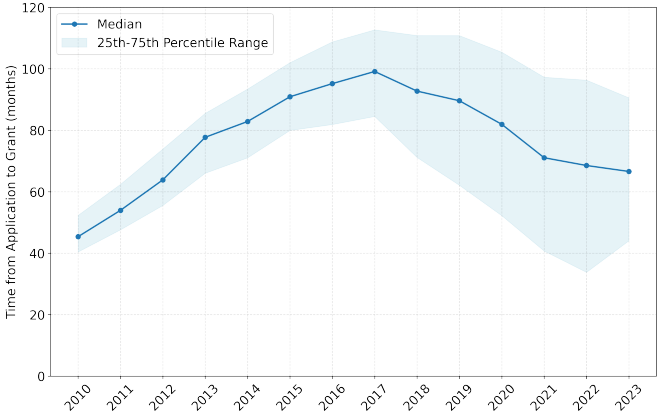
Patent Awards Coverage Comparison

Year	By Application Date			By Grant Date			
	IP India	PATSTAT	WIPO PATENT SCOPE	IP India	IP India Annual Report	PATSTAT	WIPO PATENT SCOPE
2009	11,386	11	10,805	4,121	6,168	24	7,936
2010	13,492	4	12,159	3,136	7,509	13	5,556
2011	14,691	2	12,146	3,668	4,381	7	4,369
2012	16,214	0	12,161	3,484	4,126	1	4,037
2013	17,376	1	11,783	2,790	4,226	1	3,150
2014	18,001	1	11,615	5,447	5,978	6	5,811
2015	20,928	2	12,421	5,608	6,326	81	5,811
2016	21,508	5	11,438	7,746	3,847	4	8,103
2017	23,661	0	11,344	12,027	13,045	3	12,227
2018	25,389	2	10,522	13,505	15,283	1	13,747
2019	25,276	0	8,946	23,096	24,936	4	20,644
2020	22,250	0	5,826	25,889	28,385	1	17,407
2021	16,581	0	2,933	30,580	30,074	0	19,720
2022	6,706	0	1,031	30,316	34,134	2	19,725

Time from Application to Granted Patents, by Grant Year



Note: This figure plots the median and inter-quartile range of time (months) from application date to grant date for Indian patents.

Median wait time for patents granted in that year is more than 5 years. Therefore, for analysis of time trends based on application date, we cut off our data at 2018 to avoid the distortion in trends

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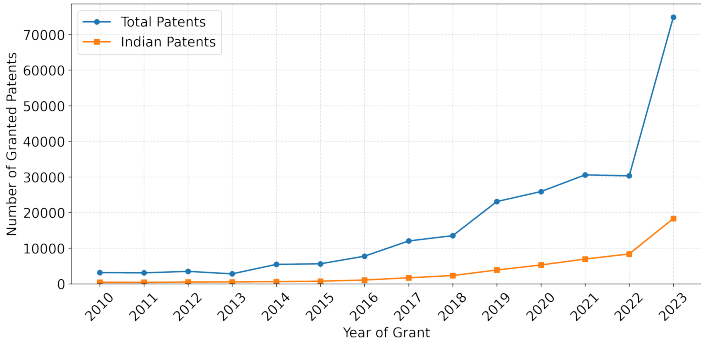
Number of Patent Awards by Grant Year

Total patents increased from just over 6,000 in 2010 to over 25,000 in 2018; Indian patents increased from less than 800 in 2005 to almost 7,000 in 2018.



Note: This figure plots the number of patent awards by the year of grant. Indian patents are defined as either (1) patents with at least one assignee whose address is in India; or (2) patents with at least one inventor whose address is in India.

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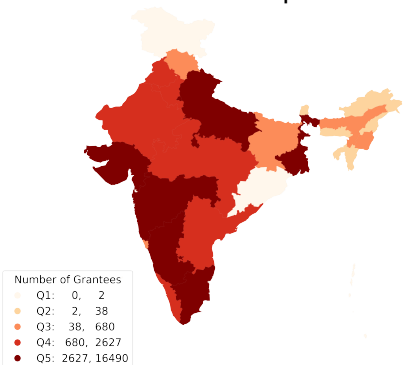
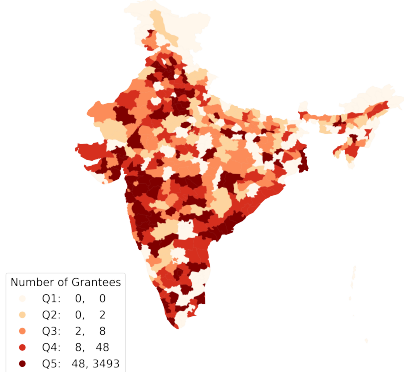
Spatial Distribution of Innovation

Within states, innovative activity is concentrated - for instance, in Maharashtra, only a few districts are responsible for greater innovation like Mumbai and Pune.

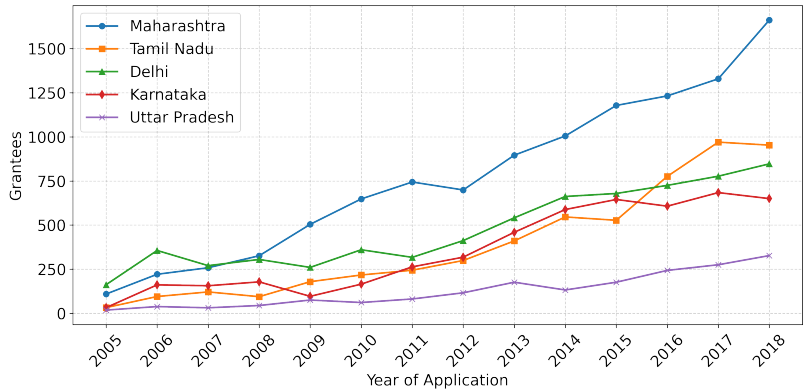




Note: This figure plots the distribution of inventors and grantees by state and district in quintiles for Indian patents from 2005 to 2022. The legend denotes the range of inventors and grantees in each quintile. Each observation is an inventor/grantee-patent pair. Indian patents are defined as either (1) patents with at least one assignee whose address is in India; or (2) patents with at least one inventor whose address is in India.

Stability of Trends in State-Level Innovation

Number of Grantees by State



Note: This figure plots the number of patent inventors and grantees of Indian patents by state in the top 5 states between 2005-2018. The x-axis represents the application filing year. The legend presents the states in descending order of total inventors. Each observation is an inventor/grantee-patent pair.

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Top Indian Patent Grantees

Thirteen companies, six academic institutions, and one a (non-academic) government organization. CSIR recd. 3.2% of all patents in this period.

Rank	Organization	Type	#Patents
1	Council of Scientific and Industrial Research	Academic Institutions	2154
2	Bharat Heavy Electricals	Business	1779
3	TVS Motor	Business	1679
4	Tata Service	Business	1635
5	Samsung Electronics	Business	1186
6	Mahindra & Mahindra	Business	1100
7	Samsung R&D Institute India Bangalore	Business	1065
8	Tata Steel	Business	1032
9	Tata Motors	Business	1029
10	Indian Institute of Technology Bombay	Academic Institutions	944
11	Indian Institute of Technology Madras	Academic Institutions	925
12	Schneider Electric India	Business	822
13	Wipro	Business	721
14	Director General of Defense R&D Organisation	Government	649
15	Maruti Suzuki India	Business	624
16	Indian Institute of Technology Delhi	Academic Institutions	535
17	Hindustan Unilever	Business	517
18	Indian Institute of Technology Kanpur	Academic Institutions	484
19	Indian Institute of Science	Academic Institutions	436
20	Reliance Industrial	Business	429

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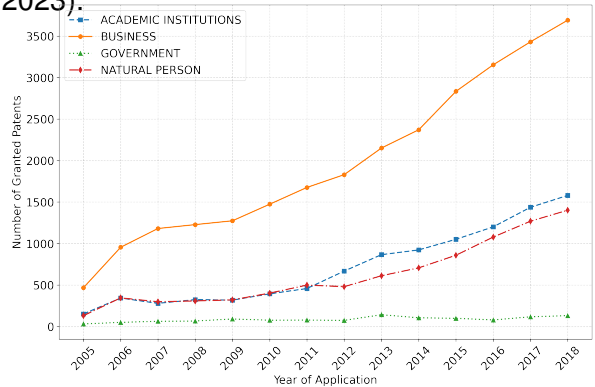
By First Grantee Type

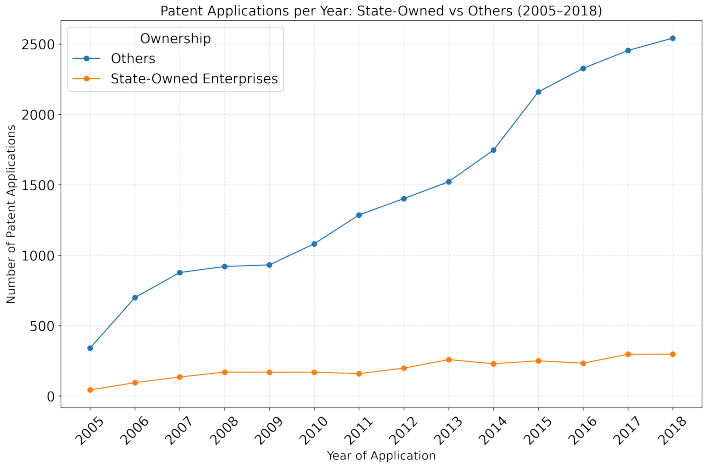
Among institutional grantees, identify 1,497 academic institutions, 79 government organizations, and 5,553 businesses. Representation of universities (22.9%) and individuals (20.6%) can be compared to the 4.5% and 1.0% in the U.S. and 17.6% and 14.0% in China (1985-2023).



Note: This figure plots the number of Indian patent awards grouped by the type of each patent's first grantee and by the year of application.

Number of Patents by First Grantee's Prowess Ownership

Gap between private sector firms and state-owned enterprises has increased over time, especially post 2009.



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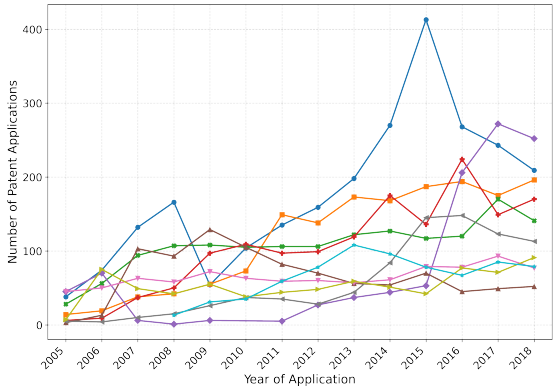
Private Sector's Drivers of Innovation



Sectoral Composition of Innovation

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- Some sectors have started with a lower relative ranking but climbed rapidly, such as telecommunications (the NIC code “manufacture of pagers, cellular phones and other mobile communication equipment”), which goes from ranked tenth in 2014 to second in 2018 in terms of number of granted patents.

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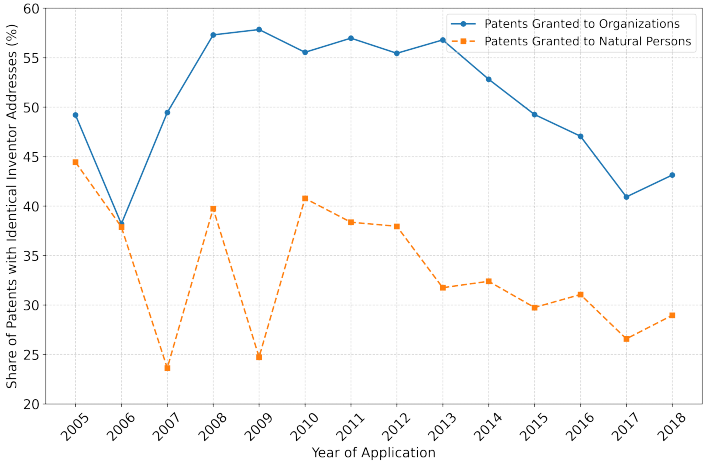
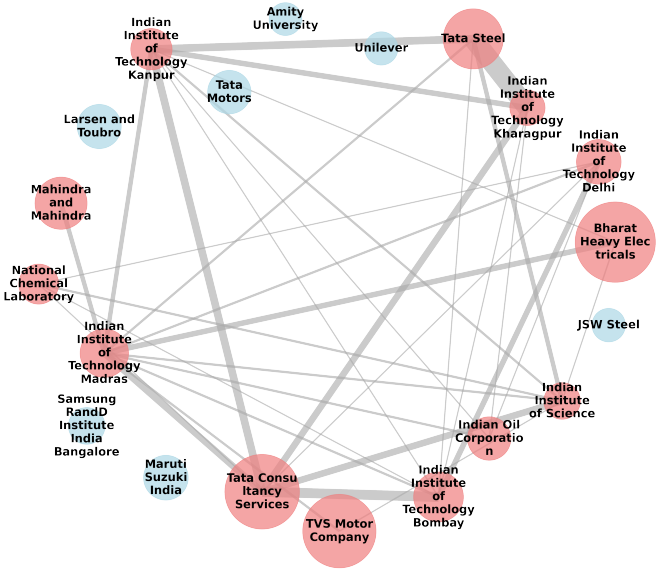
Share of Patents with Identical Inventor Addresses

Share of patents (with identical inventor addresses) comprised about 57% of patents in 2013, but about 44% in 2018 for patents granted to organizations



Collaboration Network for Top Innovators



Facts About Top Innovator's Collaboration Network

Three notable facts

- While the majority of these organizations, thirteen of twenty, have collaboration networks with other high-innovation organizations, a significant fraction do not, including large private firms such as Maruti Suzuki, Unilever, and Tata Motors.

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- Cross-organization innovation frequently takes the form of private firms collaborating with academia, such as Tata Steel's collaboration with IIT Kharagpur, Mahindra and Mahindra's collaboration with IIT Madras, or Tata Consultancy Services collaborating with the Indian Institute of Science, as well as with several IITs including Kanpur, Bombay, and Kharagpur.

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- This type of academic-private firm collaboration is much more common than private firms collaborating with each other.

Overall, the figure highlights the significance of collaborative innovation in India, and shows the importance of frontier academic organizations' participation with the private sector in recent innovation.

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- The average number of citations conditional on citing any patent has remained stable over time, at about 2.7 for Indian patents and 3 for non-Indian patents.
- Suggestive evidence shows that there is little activity in citing Indian patents
  - The top three countries of patents cited by Indian patents are U.S. (46.48%), China (14.10%), and European Patent Office (6.13%)
  - On average, non-Indian patents cite 0.003 patents filed in the Indian patent office, whereas Indian patents cite 0.048 patents filed in the Indian patent office; on average U.S. patents cite 19.19 U.S. granted patents and 6.73 between 2005 and 2018 (PatentsView Data)

Next Steps and Conclusion

Innovation an important driver of development, is increasing in India, and warrants closer study

Next Steps

- Collect data for more past years
- Build other measures of patent quality (KPST scores, abnormal stock returns)
- Match to recent policy changes

Thank You!

Department of Science and Technology, Ministry of Science and Technology, Government of India (2023). *Research and Development Statistics at a Glance*. Government of India. url{https://dst.gov.in/sites/default/files/Updated

Griliches, Z. (1984). *R&D, Patents, and Productivity*. University of Chicago Press.