Volume 9

The Physics Research Problem: A Brief Analysis of Financial and Administrative Factors Relating to Recent Trends in Research Output in Physics in India

Varad Dhodapkar
Madras Christian College

THE PHYSICS RESEARCH PROBLEM: A BRIEF ANALYSIS OF FINANCIAL AND ADMINISTRATIVE FACTORS RELATING TO RECENT TRENDS IN RESEARCH OUTPUT IN PHYSICS IN INDIA

VARAD DHODAPKAR, MADRAS CHRISTIAN COLLEGE
MENTOR: SAMUEL MOSES

Abstract

This paper attempts to view and interpret data from various sources such as the World Bank database, research and development (R&D) reports by the Indian government, Nature Index, Scopus index, and others to examine the effect that the various government financial initiatives and administrative features and policies concerning funding of institutions of higher attainment have had on India's research output in the field of physics. In addition to this, the inconsistent standards of funding across various institutes of higher education, investment in R&D activities made by other nations in comparison to India, the share of physics research output of various countries in comparison to India, the concentration of government funding amongst certain higher education institutions, and the ineffectual policies relating to scientific research over the past three decades are all touched upon to provide a more comprehensive image of the financial and administrative issues that have contributed to recent trends and slow growth in physics research in India.

Keywords: physics, research, administration, funding

Introduction

Research lies at the foundation of all of a nation's industrial, scientific, cultural, and financial endeavors. Research is the procuring and analysis of knowledge without which advancement and progress are simply not sustainable and/or viable. Physics is the most fundamental of the natural sciences, and with the recent and rapid dilution of the boundaries between the sciences, research in the field is more impactful now than ever. When reading about physics research in India, one runs into a lot of contradictory statistics and facts all pointing in opposing directions. In 2018, India was 12th in the world in terms of number of articles published in physics, at 614 articles published in a year (Nature, 2021). In the same year, according to the World Bank database, India had about 420,000 researchers in total; in comparison, Germany, a country whose population India exceeded by 20 times, had 432,000 researchers in total in the same year (World Bank, 2018). Despite periodic advancements in the field of physics, India has come to be almost universally recognized for its frugal approach to scientific endeavors as far as administration is concerned, as well as being one of the lowest investors worldwide when it comes to research and development (R&D). This paper aims to analyze physics research in India through two main points: (1) state funding and financial aid to R&D organizations and institutes of higher attainment in India, since most institutions in India depend greatly on government resources for funding, and (2) administration and policies regarding scientific research in the nation.

Analysis of State Funding to Research and Development Organizations and Institutes of Higher Attainment in India

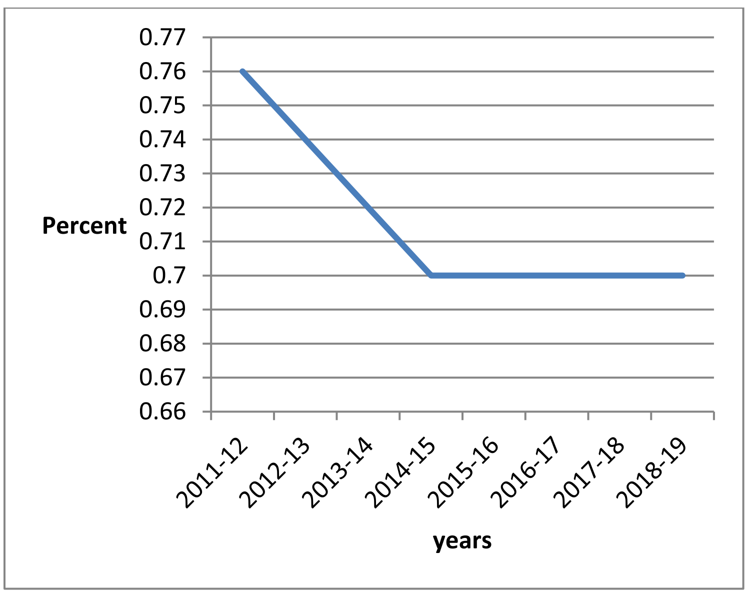

Figure 1. India's Rate of Investment in R&D Activities (% of Total GDP)

In India, most research in the field of physical sciences is funded by the government. Over the past decade, the amount of finance afforded to R&D activities in India has remained nearly the same: 0.7% of the nation's annual gross domestic product (GDP; Government of India, 2019, p. 17). See Figure 1. This is in contrast to nations such as Poland and Germany that, having populations and GDPs much smaller than India's, still invest at least twice that percentage of their GDPs. In 2019, India's GDP was 2.87 trillion U.S. dollars (USD), making the grand sum of money dedicated to R&D activities 19.6 billion

USD, of which 82.2% was concentrated among the government research agencies of the Defense Research and Development Organization, Department of Space, Indian Council of Agricultural Research, Department of Atomic Energy, and Council of Scientific and Industrial Research, leaving the remaining 17.8% (3.4 billion USD) to the 1,013 recognized universities in India (Government of India, 2019, p. 12). If we were to assume that all this money were to be divided equally among all these universities, we would get a sum of about 3.4 million USD per university. The average number of colleges per university in India is 37.5 (not including autonomous colleges). If a university were to divide the 3.4 million USD among all of its colleges equally, each college would get a sum of 90,666 USD, to be further divided into research for the arts, humanities, and sciences, and still further to be divided into specific disciplines of physics, chemistry, history, media studies, music, and so on.

Figure 2 is a graph plotted with reference to the data in Table 1, showing the total share of papers in the physical sciences published by several countries from 2015 through 2021 according to the Nature index (2021), which annually analyzes publications from 82 journals of international repute. (Nature only includes physics in the category *physical sciences*, as both chemistry and earth sciences have their own separate categories.) We see in the graph that although India has seen a growth in share of papers published worldwide every following year, the rate of growth has still been an unimpressive 3.18% in the past seven years. If we refer to Table 1, we can clearly see that India’s share has still been quite low in comparison to that of countries such as Italy, the United Kingdom, and Switzerland, all of which have a combined number of nearly 460,000 researchers, only slightly higher than India’s 420,000. One very important and noticeable reason for this inconsistent relationship between number of researchers and total share of papers published is that of those three nations, Switzerland (a country whose GDP India exceeds by more than three times) alone invested 24 billion USD (23 billion CHF) in R&D activities in 2019, compared to India’s 19.6 billion USD in the same year (SwissInfo, 2021). This figure clearly represents the lack of monetary resources available to researchers in India.

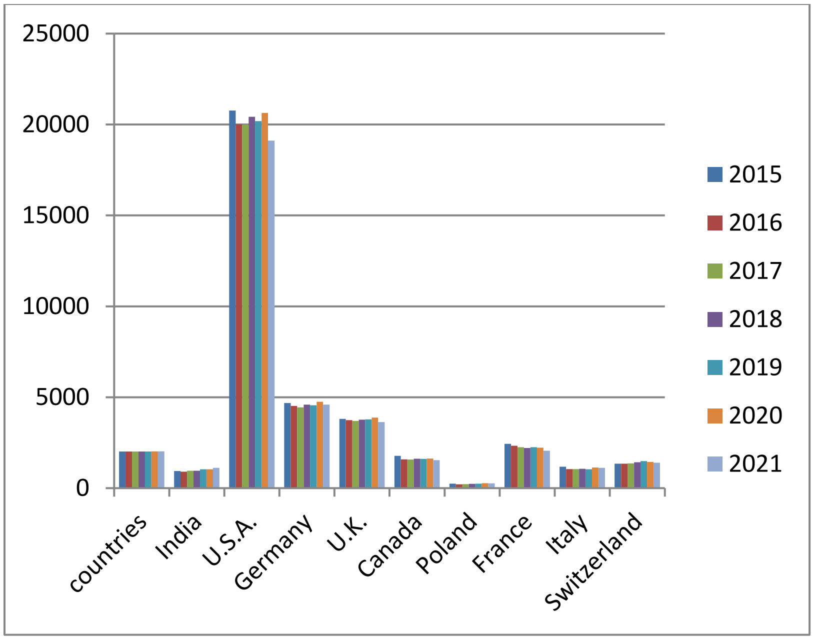

Figure 2. Comparison of Research Share in the Sciences by Country

TABLE 1. Share of Research Papers per Country

	2015	2016	2017	2018	2019	2020	2021
India	943.19	905.2	958.36	963.22	1,040.69	1,037.63	1,114.06
USA	20,770.86	20,010.55	20,000	20,423.5	20,184.42	2,0635.4	19,117.57
Germany	4,682.2	4,519.29	4,443.39	4,595.71	4,558.38	4,754.21	4,592.02
UK	3,807.94	3,738.28	3,695.92	3,761.93	3,780.62	3,882.24	3,630.15
Canada	1,777.68	1,581.47	1,577.72	1,622.63	1,606.2	1,624.68	1,539.97
Poland	248.48	207.09	220.28	236.45	250.1	271.15	263.52
France	2,440.66	2,330.13	2,255.03	2,207.1	2,251.55	2,225.64	2,059.96
Italy	1,183.33	1,046.13	1,045.72	1,068.68	1,036.28	1,133.02	1,119.29
Switzerland	1,348.57	1,350.52	1,360.53	1,425.75	1,491.03	1,443.96	1,401.32

In the next section, we view the administrative features and policies relating to institutes of higher education and scientific research in India and then analyze what effect they have had on research in the field of physics.

Administrative and Policy-Based Features of Indian Academics Relating to Scientific Research

In India, as in most countries, academic institutions provide the bulk of the research output. Administration relating to these institutes of higher education is rather complex. India has four types of universities primarily recognized under the University Grants Commission (UGC). The first of these are central universities—i.e., universities placed under direct control of the central government and that include certain "institutes of national importance," such as the Indian Institutes of Technology (IITs), governed under the Institutes of Technology Act of 1961, and the Indian Institutes of Science Education and Research, governed under the National Institutes of Technology, Science Education and Research Act of 2007. Second are the state universities, a state university being one that is placed under an individual state or union territory government and that includes within it further affiliated autonomous and semiautonomous colleges, each with a varying degree of control over its own activities. Third are deemed universities, which are universities granted a status of autonomy by the Department of Higher Education and are governed under Section 3 of the UGC Act; the esteemed Indian Institute of Science (IISc) is an example. Finally are private universities—i.e., universities run by private organizations governed under the UGC (Establishment and Maintenance of Standards in Private Universities) Regulations of 2003.

There are a few immediate problems with this framework. The most obvious one is the fact that all these institutions are governed under various schemes of vastly differing characteristics. This makes regulation of funds and resources for research a difficult task. This fairly nonuniform and biased division of funds to institutions of higher education has gotten more pronounced in the past few years. In 2018, for example, more than 50% of the government funds provided to institutes of higher education in India went to the IITs, National Institutes of Technology, and Indian Institutes of Information Technology. In total, 79 institutes that harbor only 3% of the total student population of the country received more than 50% of the government funds while the rest of the 865 recognized institutes of higher education in India harboring 97% of the student population received the remaining funds (Sharma, 2018). Even the prestigious IISc, the crown jewel of research in the country, had its funding cut by more than half by the government in the same year (Sindwani, 2019). This has led to a vast majority of the research population of the country being deprived of essential resources such as access to state-of-the-art laboratory equipment and wider access to elite research journals.

Another problem is that all the numerous institutes of higher education in the country which conduct scientific research with widely varying funding, resources, and student populations have essentially been functioning within the framework of four policies since the late 1950s. These four policies are the Scientific Policy Resolution (SPR 1958), the Technology Policy Statement (1983), the Science and Technology Policy (STP

2003), and the Science Technology Innovation Policy (STIP 2013; Kaushik et al., 2020). Although these policies differ in name, they haven't had a flattering effect on the physics research output of the country across their respective implementation periods. To illustrate this, let us consider two 7-year periods, from 1993 to 1999 and from 2016 to 2022 (Table 3). The research output in physics comes to a combined total of 20,525 papers published from 1993 through 1999 for India (Gupta & Dhawan, 2009) but just 4,508 from 2016 through 2022 (Nature, 2021). One must keep in mind that the period from 1993 through 2022 covers the lifetimes of almost three of the four policies mentioned above and a nominal GDP growth rate of nearly 10.4%. (Note that the data taken from the paper by Gupta and Dhawan are from the Expanded Science Citation Index and the latter data are taken from the Nature Index, so there can be possible discrepancies and more reading on the topic is recommended.)

Table 3. Number of Physics Papers Published in 1993–1999 and 2016–2022

Year	No. Papers	Year	No. Papers
1993	2,768	2016	571
1994	2,760	2017	532
1995	2,744	2018	614
1996	2,972	2019	650
1997	2,993	2020	694
1998	3,065	2021	697
1999	3,223	2022	750
Total	20,525	**Total**	4,508

Conclusion

This paper briefly reviewed various administrative and financial aspects in relation to physics research output in India. We have seen that a combination of complex reasons has led to the recent net downward trend and relatively slow growth in physics research output in the country over approximately the past decade. More strategic and focused administrative and funding policies need to be incentivized and applied by the various government agencies in charge of higher education, research, and distribution of the nation's annual budget. Inspiration needs to be taken from countries like Germany in terms of policies and financial frameworks for distribution of funds to organizations involved with research and institutes of higher education, and a more holistic and pragmatic way of administrating scientific research must be undertaken, in opposition to the more generalized manner in which research in the sciences has been dealt with by administrative bodies in the past few years. The government needs to realize that physics, being the most fundamental of the physical sciences, is at the foundation of advancements in technology, engineering, architecture, agriculture, and many other fields of critical importance to a nation's development and that by limiting funds for research in the field and with haphazard administrative planning, the future of the great economic and engineering projects undertaken by the nation in the past decade may lie in serious jeopardy.

References

Government of India. (2019). *Research and development report*. Department of Commerce.

Gupta, B. M., & Dhawan, S. M. (2009). Status of physics research output in India: An analysis of research output during 1993–2001. *Scientometrics, 78*, 295–316.

Kaushik, A., Basha, B. C., & Ganesan, L. (2020, January 2). Science technology and innovation (STI) policies in India: A flashback. *IndiaBioscience.* https://indiabioscience.org/columns/indian-scenario/science-technology-and-innovation-sti-policies-in-india-a-flashback

Nature. (2021). *Compare country/territory research outputs.* https://www.natureindex.com/country-territory-research-output?type=share&list=India%3BUnited+States+of+America+%28USA%29%3BUnited+Kingdom+%28UK%29%3BCanada%3BFrance%3BGermany%3BSwitzerland%3BItaly%3BPoland

Sharma, K. (2018, July 30). IITs, IIMs, NITs have just 3% of total students but get 50% of government funds. *The Print.* https://theprint.in/india/governance/iits-iims-nits-have-just-3-of-total-students-but-get-50-of-government-funds/89976/?amp

Sindwani, P. (2019, November 18). IITs, IISc say that patchy funding is delaying "Institute of Eminence" plans. *Business Insider.* https://www.businessinsider.in/education/news/iits-iisc-say-that-patchy-funding-is-delaying-institute-of-eminence-plans/amp_articleshow/72103538.cms

SwissInfo. (2021, May 27). *Swiss spend almost CHF23 billion on research.* https://www.swissinfo.ch/eng/sci-tech/swiss-spend-almost-chf23-billion-on-research/46654784

World Bank. (2018). *Researchers in R&D (per million people).* https://data.worldbank.org/indicator/SP.POP.SCIE.RD.P6