Journal of Scientometric Res. 2020; 9(3):352-355
http://www.jscires.org

Commentary

India's S&T Indicators 2019-20: What it Reveals and What Remains Hidden

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ABSTRACT
Department of Science and Technology, India recently released the S&T indicators for the year 2019-20 which once again reveals the stagnation of India's gross expenditure in R&D at 0.7 percent of the GDP. The R&D trends such as contribution by private sector and higher education sectors in R&D shows a continuous rise in absolute figures although their share in total R&D remains the same as previous years. The output indicators such as patents and publications have also shown an increasing trend, but India still lags behind the advanced and innovative nations. These indicators however do not divulge the true picture of innovations in India as they are focused towards capturing formal sector innovations. Indian economy is dominated by the informal sector and the innovative activities within this sector could not be represented through these conventional metrics.

Keywords: Innovation, Science and technology, R&D investment, GERD, Informal sector innovations, India.

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Received: 27-10-2020
Revised: 15-11-2020
Accepted: 29-11-2020
DOI: 10.5530/jscires.9.3.43

INTRODUCTION

Innovation is widely accepted as an essential driver of economic progress of any nation. In academic literature, the understanding and definitions of innovation differs greatly but in simple terms it can be defined as the implementation of a new or significantly improved product, process, or service.[1] Since innovation is complex and varies across national contexts, countries around the world came up with their national innovation policies towards fostering an innovation culture within their geographical boundaries. India also joined this club in the year 2013 by announcing its science, technology and innovation (STI) policy at the centenary sessions of the Indian Science Congress. This was a few years after that the then Prime Minister of India, Dr. Manmohan Singh declared 2010-20 as the "decade of innovation". One of the main aims of India's STI policy was to enhance the role of private sector in its national innovation system and thus increase the expenditure on research and development (R&D) to 2% of GDP.[2] Though India has improved its standing on the Global Innovation Index from 62nd position in 2011 to 52nd in 2019, it still remains distant from its target of increasing its gross expenditure on research and development (GERD) to 2% of GDP. GERD was one of the main indicators which came out of the Frascati Manual of Organisation for Economic Co-operation and Development (OECD) as a measure of innovation in a country.[3] OECD defines R&D as "creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock of knowledge to devise new applications".[4]

Though R&D as an indicator of innovation is broadly contested mainly for capturing just a part of the innovation process, it is used extensively as a proxy for innovation and international comparison. Many nations therefore publish their science and technology (S&T) indicators under the rubric of R&D which primarily includes expenditure of public and business sectors in R&D activities, headcounts of researchers and patents. Department of Science and Technology (DST) under Ministry of Science and Technology, Government of India recently released the R&D statistics of India for the year 2019-20. The report highlights major findings of the national S&T survey launched in the year 2018-19 for compiling the major R&D indicators. These findings are analysed here critically in the purview of the Indian context. More precisely, we attempt to take a closer look at India's innovation scenario and relate them with the performance of other major innovative nations.

Trends in R&D Investment

India's GERD has been consistently rising over the years from Rs 65,961.33 crore in 2011-12 to an estimated Rs 123847.71 crore in 2018-19 (Figure 1). However, its GERD to GDP ratio has remained stagnated at around 0.7 percent in the last decade far from the target of 2 percent laid down

by the STI policy 2013. This is not only lower than some of the most advanced and innovative nations of the world like Israel (4.6 percent), South Korea (4.5 percent), Japan (3.2 percent), Germany (3 percent) and USA (2.8 percent) but even in comparison with BRICS nations India's spending has been lower. For instance, China spends around 2.1 percent, Brazil 1.3 percent, Russia just over 1 percent and South Africa around 0.73 percent. One of the main reasons for India's stagnated GERD to GDP ratio has been the private investments in R&D which have failed to keep up with the public investments. In technologically advanced nations, most of the R&D is carried out by the private sector but in India government still remains the primary source of R&D funding.

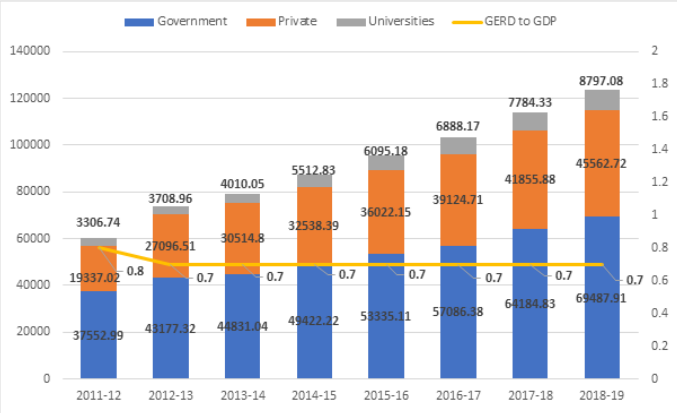

Figure 1: R&D Investment in India by Different Sectors (2011-12 to 2018-19).

The R&D expenditure by private sector in India has although increased from Rs 32,538.39 crore in 2014-15 to Rs 45,562.72 crore in 2018-19 but its share in GERD has declined from 37.20 percent in 2014-15 to 36.79 percent in 2018-19. Moreover, most of the private R&D investment is concentrated in just three sectors – pharmaceuticals, automobiles and software.[5] The increase in private sector's share of GERD is desired as the output of their investment tend to result in implementable products more quickly than the government sector where much of the research do not produce output which may be used by the nation as a whole.[6] The STI Policy 2013 also aspired for the increase in private sector's share in GERD to match that of public sector. However, even today public sector remains the major contributor which is around 62 percent of the total GERD.

Almost 60 percent of the expenditure on R&D by major scientific agencies under the public sector is consumed in strategic sectors of defence, space and atomic energy. Another feature of the government contribution in GERD is that it is almost completely (88 percent) undertaken by the central government. The spending by state government has been abysmal over the years. The state governments need to increase their investments in R&D specifically in those research areas which are more specific to their context. Coming to the investment made by higher education sector in GERD it is observed that it has doubled from Rs 3506.62 crore in 2011-12 to an estimated Rs 8797.08 crore in 2018-19. However, its contribution to overall GERD is a mere seven percent. The contribution of this sector in OECD countries accounts for 20 percent while in Japan and China, the universities accounts for around 15 percent and 12 percent of the GERD.[2] The Higher Education Institutions are considered to be a major source of human resource required for the various actors in the national innovation system of the country.[6] There were 40,813 doctorates awarded in India in 2016. Out of which, 24,474 (60 percent) were from S&T disciplines. India is behind only US and China in number of doctorates awarded in S&T disciplines. The number of researchers per million people in India was 255 in the year 2017 whereas the R&D expenditure per researcher in India was $ 185,000. India lags behind nations like China (1200), South Korea (7100) and the US (4300) in terms of researchers per million inhabitants[7] which reveals that countries with a higher GERD to GDP ratio have greater research capacity. Though government has initiated various research schemes to boost the quality of research in India, the same have been limited to only premier institutions of the country. The government funding for research and innovation in academia is thus skewed and inadequate. The higher education sector as a whole need a transformation through government intervention to enable high-end research to fructify. It requires not only financial but infrastructure support for developing both basic and applied cutting edge research and making the higher education institutions as a source of technology.

Patent and Publication Trends

Patents and publications are indicators which provide a measure of the output of a country's R&D. In the year 2017-18, a total of 47,854 patents were filed in India. Again, this number is small compared to nations like South Korea, the US and China. Further, in India only 15,550 (32 percent) of these patents were filed by Indian residents while the rest 32,304 were filed by the foreign residents. This is in contrast with other innovative Asian nations like China (90 percent), Japan (81 percent) and South Korea (77 percent) where majority of the patent filings are done by residents. Among the foreign patents filed in India, 18,179 were filed by the US (56 percent) followed by 4,487 by Japan (14 percent) and 2,773 by Germany (8 percent). Qualcomm and Philips have been the top foreign resident patent applicants in India by filing 960 and 737 applications respectively. Though the patents by foreign firms in India are on the rise the number of patents filed by Indian companies in US are declining. A recent report stated that the number of patents filed in the US by India domiciled firms declined 12.3 percent from 1,526 in 2017 to 1,338 in 2018-19.[8]

Among the Indian applicants of patents in India, Council of Scientific and Industrial Research has been the top applicant with 176 patent filings followed by Defence Research and Development Organisation with 126 applications. From higher education sector, Indian Institutes of Technologies filed the highest patent applications (540) followed by Amity University and SRM University with 119 and 81 applications respectively. Indian Institute of Science, considered as the premier institute of India, filed 58 patent applications in the year 2017-18. As per World Intellectual Property Organization (WIPO) the patent office of India stands at the 7th position among the top 10 Patent Filing Offices in the world behind China, US, Japan, South Korea, European Union and Germany. Patent applications filed in India are dominated by disciplines such as mechanical engineering, chemical engineering, computer/electronics engineering and communications. One of the reasons why researchers shy away from patenting their innovations in India is due to the time taken to get a patent. Indian patent office on an average takes 64 months to grant a patent, compared with 22 months in China and European Patent Office and 24 months in the US Patent Office.[9] As a result, researchers in India tend to publish their results in journals rather than filing patents.

The performance of India in scientific publications continue to show an increasing trend during the last few years. This increase in publications is reflected in databases such as Scopus and Science Citation Index (SCI). The number of publications from India increased from 90,864 in the year 2011 to 1,36,238 in the year 2016 in the Scopus database whereas in SCI database, India's publication output increased from 47,081 in 2011 to 64,267 in 2016. India ranks third in science and engineering articles in all fields as per the National Science Foundation database for the year 2018 while the Scopus database ranks India at fifth place with a share of 5.4 percent of the world output. As per the SCI database, India ranks 10th in the scientific publication output with a share of 4.1 percent of the world output.

Despite this increase in high-quality scientific publications, Indian publications report a low citation impact which puts a question on their quality. The relative impact of citations for India is half (0.51) of that of the global average (1.0).[7] Moreover, India holds the dubious distinction of contributing one-third of articles in the predatory journals.[10] There are several other studies which found Indians to be the largest contributors to the predatory journals.[11,12] This has been a major reason for the Indian universities to continuously fare poor in the world rankings. Though University Grants Commission is trying to curb publications in the fake journals, the process has been doubtful as publishing in the fake journals continue to grow.

What these indicators fail to capture

The indicators such as R&D, patents and publications as measures of input and output of a nation's innovation has been accepted through establishment of concepts, guidelines and surveys by various OECD manuals.[13] These indicators therefore capture innovations from the formalised sectors of the economy which are a hallmark of high-income nations. However, in India where around 88 percent of the workforce is still engaged in the informal economy[14] contributing to two-thirds of the GDP, these conventional metrics fail to highlight the innovations occurring there. The informal sector is widely recognised as a site of innovative activities[15] but the surveys conducted to measure innovations fail to acknowledge them. Shekar and Paily[16] argue that traditional innovation metrics such as patents and publications view innovation measurement through a formal lens and as most of the innovation processes occur through informal channels, a large portion of India's innovation are left out.

There are many aspects of innovations which cannot be measured directly. Knowledge is one such aspect of innovation. Basole[17] writes that there exists a vast store of knowledge in the informal sector along with well-established institutions of knowledge transfer which are poorly understood. Hence, even the official surveys to identify knowledge basis of the informal sector are inadequate in capturing the in-house knowledge of the workers, their informal networks and their ability to adapt or imitate formal network knowledge as per their requirements. Knowledge generated in the informal sector which is tacit and localised is completely ignored by the innovation policies.[18] Therefore, one fails to find acceptance of the innovative potential of India hidden in the informal sector in such policy documents. Scholars have argued in the past that India's S&T policy has always prioritised R&D for developing innovative solutions for problem solving in the rural areas and ignores the innovations which already exists there.[19]

Informal innovation cases are widely scouted and documented by the National Innovation Foundation (NIF). NIF till date has scouted around 310,000 innovative ideas and practices. The stories of innovators documented by NIF reflect that people at bottom of the pyramid, outside the formal economy can also be the agents of innovations. A growing scholarship on such innovations have developed in the last two decades and refer to these innovations by various terms such as grassroots innovations, frugal innovations, *Jugaad*, or simply informal sector innovations.[20,21] These innovations are often developed by individuals or communities at grassroots level either for self-use or for the use of their community members. What makes these innovations different from the formalised R&D sponsored innovations is that they are constrained based and developed using locally available resources.[22] The incentive

structure and motivations behind the development of such innovations are also different.[23] Most of the innovators in the informal sector are unaware of tools such as patents and believe in open sharing and diffusion of their innovative ideas.[24] This is another reason why such innovations do not feature in the conventional S&T indicators.

To present the real picture of innovativeness of a country like India, there is need to develop indicators which go beyond the conventional metrics. As mentioned in the innovation literature from the low-income or emerging countries, innovation is based on concepts which go beyond enterprise and firm level incentives such as increased revenues and market share.[13] Thus, capturing the innovativeness of informal sector of nations like India and to uncover the innovations developed within them would require focussing on the outcomes of those innovations. The indicators such as R&D investments, patents and publications cannot be used as proxies for measuring the informal sector innovations.[25] Unless a standard way of measuring the value of innovations in the informal sector is developed that go beyond the typical S&T indicators, the actual scenario of India's innovativeness will not be revealed.

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