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Contribution of universities in Indian research and development

Dr. Sandeep Kaur

Assistant Professor in Economics Guru Nanak College, Budhlada, Punjab, India

Abstract
With the fast pace of change and due to the impact of globalization, the role of the higher education institutions in furthering research and development is becoming important. It is recognized worldwide that investing in higher education is a good thing for the economy and society. Greater investment in universities increases the quality and quantity of highly educated graduates. We are increasingly seeing more investment in university based R&D which increases productivity and the number of highly trained research graduates (PhD's). Graduates take their experience and knowledge to future employers and become key players in the knowledge society/economy. Universities played a very special role in each country– not as drivers of innovation, as commonly viewed in the West, but as shapers of human capital formation. Every nation considers research and development as the basis for its overall progress. The purpose of this study is to identify the position of India in the global scenario of basic research, to explore the concerns and opportunity of higher education R & D. It also describes how universities perform vital functions both as generators of new knowledge through their leading-edge research activities and as trainers of highly qualified labour.

Keywords: Higher Education Institutions, Innovation, Productivity, Research and Development

Introduction

In recent years, innovation is universally regarded as an engine of economic growth in developing as well as developed countries. To set effective innovation policies, policy-makers need trustworthy indicators to benchmark and monitor these policies. Research and experimental development (R&D) is an important component of a country's national innovation system (NIS) and R&D statistics are among the most widely used indicators to monitor the NIS.

Innovation activities include knowledge generation and transfer, the purchase of technologies, product commercialization as well as research and experimental development (R&D). As such, the ability to perform, commission, measure and manage R&D is an important facet of economic competitiveness and national development. There are several reasons for this:

- R&D is central to the capacity to adopt and adapt technologies through technology transfer.
- Local development problems require local solutions and perspectives. Technological solutions are socially and culturally embedded and, as such, must take indigenous knowledge systems into consideration. Culturally sensitive R&D that works alongside and collaborates with indigenous knowledge practitioners offers the potential to transform this R&D into various innovations.

With the rise of the knowledge intensive economy, the contribution of university research to economic performance becomes more vital. Among the key contributions that universities make to economic growth in the knowledge-based economy are the performance of research and the training of highly qualified personnel, both of which are sustained by networks and social interaction; universities act both as a primary source of 'knowledge workers', as well as the key factor of production – knowledge itself. This additional role is now recognized by the Government as vital from the point of view of attracting more international companies and supporting expansion and innovation in indigenous firms. During the second half of the 20th century, universities were at the forefront in training generations of highly skilled, technologically sophisticated graduates who could be employed successfully by domestic firms seeking to enter global industries, by multinational corporations, and not least by the institutions steering the economy's industrial development.

Definitions of Research and Development

The term research usually refers to uncovering or generating new knowledge, or solving particular practical or theoretical problems. With its increasing importance, various definitions have been given to account for a wide range of activities and disciplines. Research is defined as systematic study directed toward fuller scientific knowledge or understanding of the subject studied. Research is classified as either basic or applied according to the objectives of the sponsoring agency.

Basic research

Basic research is defined as systematic study directed toward fuller knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards processes or products in mind.

Applied research

Applied research is defined as systematic study to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met.

Development

Development is defined as systematic application of knowledge or understanding, directed toward the production of useful materials, devices, and systems or methods, including design, development, and improvement of prototypes and new processes to meet specific requirements. Hence, Research and development (usually abbreviated as R & D) activities are aimed at making scientific discoveries and

inventions that are commercially attractive.

The Role of universities

Universities provide the ideas and inventions on which future prosperity will be founded, making a difference to people's lives in globally. They play a central role, not only as producers of basic research, but also by creating human capital in the form of higher-skilled labour. Academic research and development is now seen as one of the key drivers of economic growth. Countries that have academic institutions performing large amounts of R&D are more able to attract and grow technology orientated companies. Academic R&D is an integral part of the innovation economy, with contributions in the form of patents, new commercial products, skilled employees, new companies, job creation, and tax revenues. Assessing the impact of this university research on GDP and jobs begins with measuring the impact of research on the Total Factor Productivity (TFP) of an economy. TFP is the economic growth that results from increases in the efficiency and productivity of labour and capital. Much of the improvement in TFP results from advances in society's stock of knowledge, and an increase in the ability of the workforce to apply it. In this context the link between universities to economic growth and change is clear.

It is important to remember that significant advances in knowledge are usually the result of basic research, not applied research; the social gains expected from basic research are obvious. However, many elements of university and government research have very low returns and overwhelmingly contribute to economic growth only indirectly, although these indirect effects can be important and often take the form of knowledge spillovers to the private sector. All the most important technologies such as aviation technologies, space technologies, semiconductors, the Internet, nuclear power and nanotechnology have driven growth trace their funding back to government. However, these government successes have been influential mainly through their impact outside the public sector.

To study the university research spill over to industry, Mansfield (1991) found, by studying the selected firms in information processing, electrical equipment, chemicals, instruments, drugs, metals and oil industries, that about one-tenth of the new products and processes commercialised from 1975 to 1985 could not have been developed (without substantial delay) if not for recent academic research undertaken within the last 15 years. The strongest evidence comes from the study of specific industries known to rely on university research for technical advance.

More recent studies have found that gains in productivity were even greater in countries where research was concentrated in universities as opposed to government laboratories. This may reflect the focus of research in these laboratories which address public missions that do not impact directly on productivity (defence, health and environment), whereas universities provide industry with the basic knowledge required for technological innovation.

In short, University research helps to: meet the grand challenges of the 21st century, such as overcoming resource scarcity, ensuring global food security and tackling global warming; shape policies in areas like international relations, health and education; discover and develop the technological advancements that will create new opportunities for how we live our lives; cure diseases and innovate models of service and care; enrich lives through culture and the arts support overseas development.

Position of India in the global scenario of basic research

The performance of university sector was quite significant in 1950s and 1960s. It has fallen significantly in recent years. In OECD countries, research from academic institutions accounts for about 15-35 per cent of the overall R & D effort of the Country. In basic research, as much as 60 per cent or more is contributed by the academic institutions. In the US there is a very strong relationship between undergraduate / postgraduate teaching and research. In the well-known universities of the US, the undergraduate students have a good exposure to eminent research scientists; which is lacking in the Indian system. Further, the academic institutions in India are often severely under-resourced. It is seen that the researchers in India emulate topics of the developed economies often to the neglect of local need and national priorities, in order to get published and gain respectability.

Though all universities are expected to have research focus and be comprehensive in their focus both on teaching and research, data on doctorates, particularly in science, engineering and medicine suggests that only a few institutions have real research focus. Sustained research efforts made by the faculty are eventually reflected in recognition of their work at the national level. Such recognition includes membership of science academies. Even here, it is seen that the distribution is skewed. According to the Research Handbook (UGC, 2005), only about 20 out of the 120 traditional universities have a fellow in one of the three science academies, namely – Indian National Science Academy (INSA), Indian Academy of Sciences (IAS), Bangalore and National Academy of Sciences (NAS), Allahabad.

India is gradually progressing in its R&D efforts and there are some notable examples of innovative products such as the Tata Nano, GE's portable electrocardiography (ECG) device, Pureit water filters and Micromax phones. The drivers for these innovations are local needs, user preferences and most often the paying capacity of the customer. This has given rise to a new paradigm of innovation, often referred to as "frugal innovation", the "Gandhian innovation" or "constraint-based innovation". Patenting, which is an important measure of innovative R&D activity, is also on the rise in India. Patent registrations in the US from India grew from 94 in the year 2000 to 465 in 2010, and registrations in Europe increased from 7 in the year 2000 to 200 in 2010. High tech hubs such as Bengaluru, Chennai, Delhi, Hyderabad, Mumbai and Pune have seen the maximum patenting activity. The share of patents filed by Indians at the Indian Patent Office has been rising marginally over the years.

Concerns and opportunities

It is seen that despite a very large system of higher education and a significant number of science and engineering graduates, research output of India in terms of publications, particularly its quality, patenting, high technology exports is poor. India ranks rather low on various competitiveness indices.

There is a lack of adequate linkages between universities and research laboratories on the one hand and universities and businesses on the other. With very little being spent on research through higher education institutions, the required

infrastructure and experimental facilities for research does not exist; whatever exists is not being optimally utilised due to lack of collaborative work and absence of the culture of sharing of facilities. There is waning interest in science at the school level. Bright students are not opting for science at the degree level and beyond. The status of doctoral education is disturbing. Their numbers are not increasing to meet the growing demand from the public sector research labs and higher education institutions. There are a small number of university level institutions that produce a decent number of doctorates. Even amongst them, there is a suspicion about the quality of doctoral education from at least some that are not known to be reputed, yet contribute to a significant numbers of doctorates. Doctoral theses in social sciences often apply a descriptive approach to specific limited topics without really relating it to a wider socio-political and economic context. Therefore, there is a need for a more analytical and comparative approach in doctoral research and relating it to society, policy and economy. A study conducted on Social Science Research Capacity in South Asia – 2002 showed that the share of the Indian universities in the special articles published in the Economic and Political Weekly was only about a 25 per cent. This too was dominated by only three universities, namely - Jawaharlal Nehru University, University of Mumbai and University of Delhi.

Many Indian universities have a limited international exposure. India has an estimated full-time equivalent R&D professional strength of only 150 professionals per million, compared to that of other countries. Academic institutions and many public research centers focus on advancing the science, focusing on patenting and publishing, very little systematic attention is being spent in applied R&D. Despite the growing talent pool, Indian R&D remains globally non-competitive. However, unlike the developed countries, this would have a cascading effect in India. The country will not be able to attract talent from outside; rather it would lose nearly all talented students who happen to study basic sciences on their own (rare) or who drift (majority) to such courses in the absence of their preferred professional subjects

Hence, for the R&D to grow and sustain, many challenges such as the uncertainty, high degree of complexity, difficulty in framing clear specifications, need for continual course correction, constraints of outsourcing process etc. need to be overcome, especially if the investments are high and anticipated return are low. Also, the investment in R&D may not always fetch returns immediately. The outcome as well as the path to be adopted may not be fully clear at the beginning of a R&D project, and hence varieties of challenges are encountered in every stage of R&D execution.

The concerns above are real. Addressing these concerns is essential to seize the new opportunities that are available to India in the modern world. The job market for higher science and technology professionals has improved with a large number of global R&D centres being set up in the country. India is doing reasonably well in the pharmaceutical and automotive sector. Over the last few years, 150 MNCs have set up R & D Facilities in India (120 in last 5 years). These are in diverse fields - not only confined to IT sector. Though these are mainly confined to development research and not in the cutting edge technology areas, yet this is a healthy development. The reason for this development is the low cost manpower around four to six times cheaper in India and a huge talent pool in English that the country has. It needs to be realised that the total investment in these R&D centres is not huge. These centres do not create jobs in huge numbers. As a result their direct impact on national income may not be significant. Yet, when R & D flourishes, the growth in manufacturing and other services would become inevitable. This helps the country to take new trajectory of growth. It is now seen that under pressure of the global competition, even the domestic private sector is keen to invest in the technology development.

Conclusion

In a nutshell, Universities do not only change lives through education only, but also through the wider impact of their research. Universities can contribute to the economic success of a region by deepening the skills and knowledge—or human capital-of its residents through R & D. Producing graduates who join the region's educated workforce is one way these institutions increase human capital levels. In addition, the knowledge and technologies created through research activities at area universities may not only attract new firms to a region but also help existing businesses expand and innovate. Universities and R&D institutions in developing countries are therefore currently being urged to seek active involvement in consultancy and R&D activities as a means of: enhancing dissemination of knowledge and technology transfer; generating income for the further support of teaching and research activities; generating income for staff to enhance staff retention. Obviously contribution of universities in Indian research and development has been growing at a faster rate during recent times.

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