Is an economic 'input–output' model applicable to Indian science?

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The recent report of the Science Advisory Council to the Prime Minister (SAC-PM) has reviewed the state of science in the country[1]. In this report, the word 'science' is used as a generic term that includes mathematics, engineering, technology, medicine, agriculture and other related subjects. While referring to 'our vast but unutilized potential', the report praises the discoveries made by J. C. Bose, C. V. Raman and S. Ramanujan, but laments that while these discoveries in basic science spawned new technologies, they were utilized abroad and not in India. It then goes on to ask the question: 'Why did all these applications emerge in the West (and) not in India?' The report concludes that 'the journey from idea to product is complex, and demands science and technology be developed in a variety of other fields for quite different applications and a variety of expertise all the way from science to manufacture, financing and market knowledge.' The report demands a new ecosystem that encourages innovation. The present commentary is asking how Indian science can be evaluated as a 'business entity' in this new ecosystem.

At the outset, the present author confirms his full faith in increased commitment of the Government to the funding of science in India. However, the scientific community has a responsibility of showing how the support provided to Indian science, in the past, has also resulted in 'tangible' benefits to the country. The new ecosystem must include an analysis of, what is called here, an economic 'input–out' model for Indian science.

An excerpt from the cited report of the US National Academy says 'economic studies conducted even before the information technology revolution have shown that as much as 85% of measured growth in the US income per capita was due to technological change'[2]. This implies that economic studies of the impact of technology could be made, and 'output' quantified, in terms of how the national income per capita could be linked to technological inputs. Have the experts of Indian economy carried out such an exercise to relate India's economic growth to indigenous science and technology efforts? A quantified economic 'input–output' assessment could concretely justify the enhancement of resources for science in India. The quantified exercise could also lead to critical administrative, fiscal and business-like approaches that need to be introduced in the proposed 'new ecosystem'. The Science, Technology and Innovation (STI) Policy of Government of India[3] brings in the concept of innovation that has also been discussed in detail in the SAC-PM report[1]. Reference is repeatedly made to the relation of science and technology with the processes of manufacture, finance and marketing – areas which the scientific community has often ignored. India needs an innovation approach for converting our knowledge assets to economic growth – a new paradigm for the scientific community.

The innovation ecosystem recommended by the SAC-PM states: 'Innovation is not just about patents and new products, though these are important outcomes of innovation. It is equally about new ideas, services, and even business models.' The reference to a business model is again an economic concept that relates to an input–output analysis of investment. In any business model, there is a reference to 'return on investment' (ROI). The new ecosystem for innovation is therefore expected to give some consideration to the ROI that will go into science. In this new ecosystem, an input of Rs 1000 crore/year is recommended as a venture fund. Fiscal benefits such as tax incentives are included; a social innovation fund is proposed to be set up; strengthening of IPR laws is recommended, and a specific package for small business initiatives is recommended. Looking at some aspects of science as a 'business' is indicated. Unfortunately, the report does not provide information on what returns these investments are expected to give. No targets are indicated. One feels that this approach to innovation is another extension of the 'R&D' funding that the science establishment is used to. If India is serious about converting some aspects of science funding into economic growth, a proper analysis has to be made of what returns one can reasonably expect for investment in innovation. One would have liked to see a 'business model' for the Rs 1000 crores to be invested as a venture capital. The SAC-PM may not have the expertise in the areas of manufacturing, financing and marketing, or for that matter in economics, to look at investments in innovation as a business model. The SAC-PM could have interacted with its counterpart body – the Prime Minister's Economic Advisory Council (PMEAC) – to arrive at some kind of an analysis, and recommendations on the kind of economic benefits that the new ecosystem could expect to achieve in a given timescale. A quick search on the internet regarding the activities of the PMEAC gives a dismal picture. The website of the Council is expected to be 'updated soon' and no press releases are available. Of the listed old reports, none refers to the concepts of innovation in science and technology and related economic benefits. One gets an impression that the former economist Prime Minister had himself not demanded the close relation that is expected between science, technology, innovation and economic returns. The new government (that has yet to renew these two Councils) should see that the SAC-PM recommendations are taken up seriously with corresponding linkages with the economic and industrial sector.

India has seen 'benefits' accrued from the inputs of science, but they are not quantified in 'economic terms' with a 'business model' approach. A quick look at India's investments in the research areas of agriculture, atomic energy, space, defence Research and industrial research gives us the confidence of the success of our scientific community in providing to the nation, not only a respectable position in the world of science, but also resulting in national development. However, like in the United States, there have been no efforts made on the part of the national planning system in India to convert, and systematically quantify, the economic benefits that have accrued to the nation. It is imperative that the benefits of science in terms of concrete economic growth are reliably estimated and

communicated to the citizens. Even some of the intangible benefits, in kind, that have accrued from science could be 'converted' into equivalent 'cash' terms through a cost-benefit analysis. The text below gives a layman's approach to highlighting the benefits from India's efforts in science, and it is hoped that it would motivate the hard-core economists to convert these 'outputs' in real terms, in the form of an economic input–output model for India's scientific enterprise.

The efforts of the Indian Council for Agricultural Research (ICAR) have contributed to the total food production in India going up from 50 million tonnes in 1950 to 255 million tonnes in 2013, making India self-sufficient in food. The scientific research inputs and other related efforts under the Green Revolution have made this possible. If we did not have this research input and had to feed the increasing population of India, we would have to import food like what we had to do in the early fifties. The financial 'input' resources that have gone into the ICAR system are known from the Government budgets. But our economists have to publicize the 'output' in terms of economic returns and project an input–output figure. Is it not possible, in a simplistic economic business model to justify India's success in the business of agriculture?

India's research in the field of atomic energy has given intangible benefits in terms of production of a large pool of scientists and engineers. The R&D in the field of nuclear research and engineering also resulted in India being able to carry out a number of peaceful nuclear explosions or nuclear bombs. This gave the country a political standing in the world of nations. But what are the direct 'economic' returns that have accrued to India in the form of useful energy? What would it have cost India to import the nuclear energy from outside? Perhaps one conclusion from such an exercise could show how nuclear energy option for India is, or is not, an economically viable business model. In any business enterprise, one has the choice of 'make or buy'. An analysis of the input–output model for India's atomic energy programme could be an interesting exercise for economists. A similar exercise could be carried out for India's inputs into defence research.

The area of space research would be a good proof of India's successful business model for a space enterprise, initiated by the visionary businessman-scientist Vikram Sarabhai. Using space technology for providing services in the sectors of communication, broadcasting, resources survey and through launching of satellites – 'making' them and not 'buying' them – has proven to be a successful 'innovation' in India's scientific efforts. These were the outcomes resulting from the efforts of basic research in space science leading to a competitive business of launching satellites for other countries, for a price. India has entered the 'business of space'. Will this enterprise interest the hard-core economists in India to evaluate the economic benefits of investments in space research?

Finally, a realistic approach to an input–output analysis may be possible in the field of Industrial research, where the CSIR system of India has been in business for a long time. It will be useful to analyse the total contribution of this research to the total industrial production in the country. Once again, the 'make or buy' approach in business should be applied to industrial production in India. Has India's industrial research business been a good innovative business model? Indians need to know.

Measuring economic and business impact of science is certainly not a new area of research in economics. The work of the Western world through the studies of the Organization for Economic Co-operation and Development (OECD)[4] set up by European countries in 1961, and economic impact of NASA's space programme[5] are well documented and used by their governments for policy planning. As India steps into the area of innovation, some of its enterprises that are part of its science activities need to be evaluated in this manner. SAC-PM has rightly brought out this need by mentioning that expertise in the fields of manufacturing, financing and marketing has to be brought into the game of innovation to help build business models for our various science enterprises.

The SAC-PM report mentions that 'the journey from idea to product is complex, and demands science and technology be developed in a variety of other fields for quite different applications and a variety of expertise all the way from science to manufacture, financing and market knowledge.' In this journey we should certainly have on board, the best of economists and industrialists who will closely work with the scientific community. To begin this journey, let the SAC-PM and PMEAC sit together and bring out their first joint report on the 'Economic impact of science in India' giving the techno-economic spin-offs from the efforts of Indian science during the last decade. This unique report should draw up a road map for the new ecosystem proposed in the thought-provoking SAC-PM report.

1. Science in India (2004–2013): decades of achievements and rising aspirations. Report of the Science Advisory Council to the Prime Minister, Published by the Department of Science and Technology, Government of India, 2013.
2. *Rising above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, National Academies Press, Washington DC, USA, 2007.
3. The Science, Technology and Innovation (STI) Policy 2013, Ministry of Science and Technology, Government of India, 2013.
4. Science, Technology and Industry Scoreboard 2013. OECD Publishing, Paris, 2013; http://dx.doi.org/10.1787/sti_scoreboard-2013-en
5. http://en.wikipedia.org/wiki/NASA_spin-off_technologies (accessed on 15 September 2014).

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