Brief for GSDR – 2016 Update

A Perspective on Science, Technology and Innovation Policy: Need for International Coordination

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INTRODUCTION

Science and Technology is essential if an economy or nation is to provide for the health, prosperity and security of its citizens. Contrary to the belief and evolution of national science policy (ies) in advanced nations; the Science Policy in 21st century needs to be evolved, keeping in view the global problems related with climate change as well as the Blue Economy or Blue Growth. The "Blue Growth" as visualized in European Union (EU) and "Blue Economy" as understood in the rest of the world and adopted as a focused area in IORA since October, 2014 is closely linked with the attainment of SDGs.

2. SCIENCE AND ITS GROWING RELEVANCE TO CONTEMPORARY WORLD:

What is Science? It may be defined both a process and as an outcome – the process of obtaining knowledge and the knowledge that is obtained. "Interconnectedness" is a basic attribute of Science. Science is a chain of models. According to Thomas Kuhn, a Physicist and historian of Science, hints at this duality when he says that Science is "the constellation of facts, theories and methods collected in current texts", while "scientists are the men (and women) who, successfully or not, have striven to contribute one or another element to that particular constellation", whereas in views of Carl Sagan, "Science is more than a body of knowledge, it is a way of thinking."

Science is generally believed or understood about both the search for "Truth" and new knowledge. The "Truth" must be obtained in an objective and systematic manner, by incorporating models and methods statistical analyses controlled experimentation and replication. Its goal is to better understand the world in which we live and to create rational and probable models that explain occurrences within it. Science is essentially "value free"; there is no place for value judgements in science. "Hard" sciences vs "Soft" sciences issue is very important to understand and generally policy makers consider "Hard" sciences like Physics, Chemistry, Biology and Geology to be worthy of government support. An optimal science policy constitutes science and technology; Science and Engineering and Research and Development. All the stakeholders, i.e. Government officials, scientific community and the broader public need to be engaged in the formulation of optimal science policy for achieving the Sustainable Development Goals (SDGs) by 2030, so that nobody is left behind and "Sustainable Development" also becomes "Inclusive Development" leading to peace and prosperity of the planet.

Since the publication of "Principles of Political Economy" in 1817 by David Ricardo, the views on the efficacy of innovations to keep the economies growing have drastically changed from "pessimism" to "optimism" and as on today innovations are helping to grow on economies in a world of finite resources.

According to Economic Cooperation and Development (OECD, "if current trends continue, as the World Population grows from 7 billion in 2010 to more than 9 billion in 2050, per capita consumption will more than triple, from roughly US$ 6600 to US$ 19,700 per year, and global GDP will nearly quadruple, requiring 80% more energy". To sustain the growth at this massive level, we need to adopt radically new business models, products and means of production implying thereby a greater role for innovation and shifting towards a strong Low Carbon Economy through materials science and digitisation which are already making an impact across the Global Economy, increasing productivity, reshaping entire industries, and creating opportunities for leap frogging by skipping less efficient and more polluting stages of development.

3. TRANSFORMATIVE INNOVATIONS

The "transformative innovations" have great potential to accelerate and increase the efficiency of the transition to a low carbon, resource efficiency and resilient economy. Infact, such innovations are already reducing climate risk. In the last 10 years, materials related to advancements have lowered GHG emissions. The costs of producing wind and solar energy have come down and in US more than 30 per cent of new electricity generation capacity added in 2010-2013 involved solar and wind power, up from less than 2 per cent in 2000-2003.

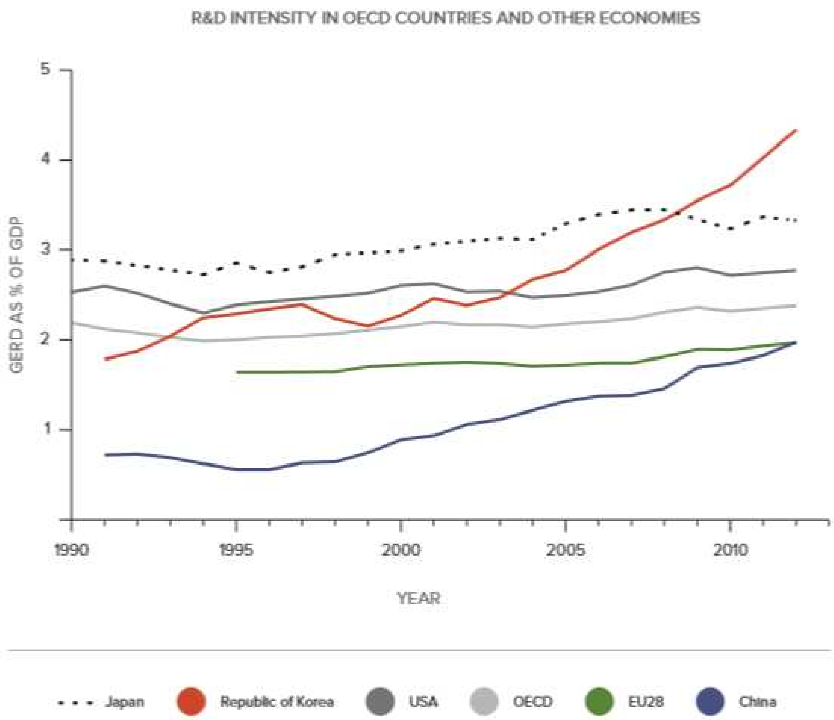
Cloud computing can lead to significant savings in energy and carbon. The research shows it can increase efficiency and reduce companies' overhead costs, and energy usage and related emissions. For example, for an office with 50 people, Google estimates IT energy use at 175 RWh per person per year, compared to 2.2 KWh when using Gmail. Cloud computing also reduces the need for in-house hardware and software expertise, which can be particularly helpful in poorer countries where such skills are less widely available. In that sense, information technology is effectively changing capital costs of renewable power, efficiency buildings, smart appliances and electric vehicles.

4. PERSPECTIVE ON SCIENCE, TECHNOLOGY AND INNOVATION POLICY:

By 1950s, Governments in advanced countries focused on the Science & Technology percentage share of GDP, but it was a part of National Science Policy 1960s "Science-Push" and "Demand-Pull" theories. During 1970s and early 1980s, the world economic environment deteriorated, forcing a shift in policy-emphasis. Technology replaced science as a more effective base from which to support national industry and economic performance. Over the period, there has been significant change in the understanding of innovation processes – and now it is "science, technology and innovation" that is prized. Innovations occur at firm or industry level. According to Lopez – Martinez (2006:78), attention thus shifted to a whole set of measures aimed not only at the generation and diffusion of knowledge, but also at stimulating the economic, institutional and social factors that influence the absorption and generation of technological knowledge. Thus in terms of objectives, Technology Policy is not much different from "Science Policy" but it represents a shift to a higher level of focus on economic objectives, i.e. focus on technologies and sectors. The key feature of Technology Policy is one in which especially science-based technologies were seen as being the core of economic growth and Technology Policy means different things for different countries.

This diagram indicates the R&D intensity in OCED countries and China. The expenditure on R&D as a percentage of GDP has been rising in South Korea, China and Japan. In most of the OCED countries it is on decline or remained constant during the period. To achieve the SDGs by 2030, the expenditure on R&D in emerging as well as in developing economies has to be increased and this may be done by creating regional R&D funds or making transparent, pro-developing, LDCs and SIDs economies in rules and regulations related with IPRs, duly taking into account the concerns of the advanced countries who are making huge expenditure in R&D. That implies a need for international coordination in STI Policy in future.

Gross domestic expenditure on R&D (GERD) across OECD countries and China



Source: OECD Main Science and Technology Indicators Database, 2014/1.

5. <u>DIFFUSION OF INNOVATION THEORY:</u>

Adoption of a new idea, behavior, or product (i.e., "innovation") does not happen simultaneously in a social system; rather it is a process whereby some people are more apt to adopt the innovation than others. Researchers have found that people who adopt an innovation early have different characteristics than people who adopt an innovation later. When promoting an innovation to a target population, it is important to understand the characteristics of the target population that will help or hinder adoption of the innovation. There are **five established adopter categories**, and while the majority of the general population tends to fall in the middle categories, it is still necessary to understand the characteristics of the target population. When promoting an innovation, there are different strategies used to appeal to the different adopter categories.

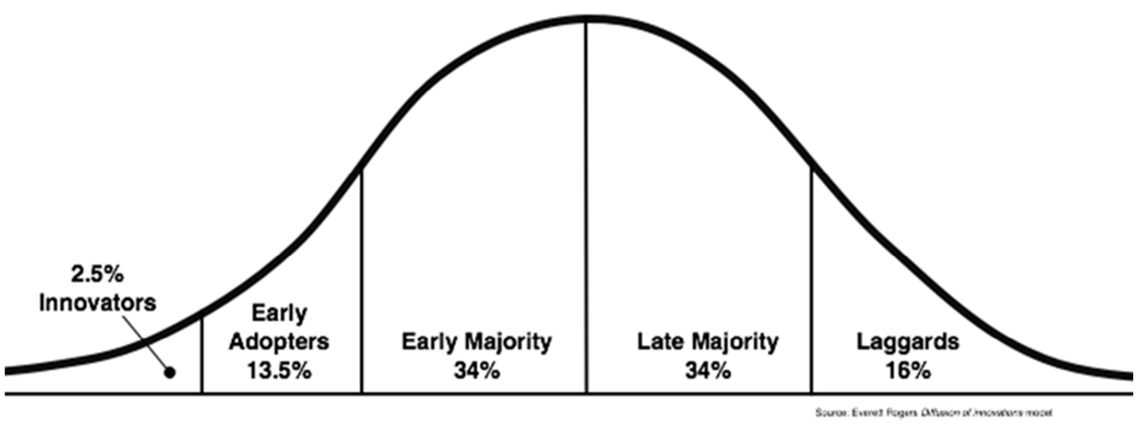
1. Innovators - These are people who want to be the first to try the innovation. They are venturesome and interested in new ideas. These people are very willing to take risks, and are often the first to develop new ideas. Very little, if anything, needs to be done to appeal to this population.
2. Early Adopters - These are people who represent opinion leaders. They enjoy leadership roles, and embrace change opportunities. They are already aware of the need to change and so are very comfortable adopting new ideas. Strategies to appeal to this population include how-to manuals and information sheets on implementation. They

do not need information to convince them to change.

3. Early Majority - These people are rarely leaders, but they do adopt new ideas before the average person. That said, they typically need to see evidence that the innovation works before they are willing to adopt it. Strategies to appeal to this population include success stories and evidence of the innovation's effectiveness.

4. Late Majority - These people are skeptical of change, and will only adopt an innovation after it has been tried by the majority. Strategies to appeal to this population include information on how many other people have tried the innovation and have adopted it successfully.

5. Laggards - These people are bound by tradition and very conservative. They are very skeptical of change and are the hardest group to bring on board. Strategies to appeal to this population include statistics, fear appeals, and pressure from people in the other adopter groups.



The stages, by which a person adopts an innovation, and whereby diffusion is accomplished, include awareness of the need for an innovation, decision to adopt (or reject) the innovation, initial use of the innovation to test it, and continued use of the innovation. There are five main factors that influence adoption of an innovation, and each of these factors is at play to a different extent in the five adopter categories.

Relative Advantage - The degree to which an innovation is seen as better than the idea, program, or product it replaces.

Compatibility - How consistent the innovation is with the values, experiences, and needs of the potential adopters.

Complexity - How difficult the innovation is to understand and/or use.

Triability - The extent to which the innovation can be tested or experimented with before a commitment to adopt is made.

Observability - The extent to which the innovation provides tangible results.

There are several limitations of diffusion of Innovation Theory and it is still in making, therefore, it is desirable to take explicit steps in formulating the optimum Science, Technology and Innovation Policy (STI Policy) which ensures the adoption and sharing of New Technologies for promoting effective industrialization in developing economies, especially in Africa. This will certainly help in achieving SDGs by 2030.

CONCLUSIONS:

Currently, majority of countries are in the quest to promote a great transformation of sectors and the economy, industrial development and science, Technology and Innovation (STI) policies overlap on the question of promoting technological learning and competence building. An optimal STI-Policy must lead to job creation in the economy through efficient industrialisation in large scale industries as well as SMEs. The FDIs inflows are also to be linked with the enhancement of technology in the priority sectors of the country.

It is also evident that the modes of promoting science, technology and innovation have been different in U.K, USA, Japan, China and other countries where R&D expenditure has been very significant. Except, U.K in all other countries Governments played an important role in the promotion of science, technology and Innovation policy (STI Policy).

The STI policy regimes need to be coordinated at the level of conceptualization, implementation and practice. The following issues need to be answered by the policy:

(i) How does innovation policy fit into the broader context of industrial development strategies of countries in practice?
(ii) Identifying the most critical areas of coordination.
(iii) What lessons can be drawn from experiences of countries in promoting policy coordination at the micro, macro levels for improved firm and they can be understood and applied to other countries.

The overlap in the policy occurs due to the existing gaps in policy articulation and design; insufficient capacity to conduct policy evaluation and monitoring; and a lack of coordination between policy-making; governmental interventions and business environment. The main elements of an optimal Science Policy inclusive of technology and innovation are as follows:

(i) The linkage between innovation and research and Research Policy may be made clear. Innovation policy needs to be pursued independently.
(ii) New initiatives need to be undertaken at international, national, regional and local levels- especially in view of the emergence of Blue Economy or Blue Growth.
(iii) Understanding the practice of Innovation and research Policies across different countries and regions(both developed and developing countries/ regions)
(iv) The gaps in policy-making structure prevailing in countries may be eliminated in order to optimize the effect of Science policy on industrialization.
(v) The existing inconsistencies in STI policy may be rectified by ensuring coherence at the levels of policy-conceptualization and design and policy-implementation and coordination.
(vi) Monitoring and Evaluation (M&E) mechanisms need to be strengthened to ensure efficient use of existing resources.
(vii) The STI and industry Policy frameworks should be adequately accompanied by private-sector including business and industry support organizations. Governments should provide adequate incentives for innovation, keeping in view country-specific requirements.

Although, all the above elements seem to be important for evolving an Optimal Science, Technology and Innovation Policy, yet the list is not conclusive and there exists a large scope to go beyond the above list.

REFERENCES:

1. Thomas S.Kuhn, The Structure of Scientific Revolutions, 3rd ed (Chicago University of Press, 1996). Also see the works of other philosophers and historians of science such as Karl Popper, Inize Lankatos, or Paul R Thagand for example.

2. Carl Sagan, The Demon-Hautned world: Science as a candle in the Dark (New York: W.W.Norton, 1998.

3. Alan J. Friedman, "Science v/s Technology", Directors column, New York Hall of Science Press Room, http//www.nyhallsci.org/nyhs.pressroom/nyhs.directorcolumn/de-sciencevstech.html (accessed April 30, 2007).

4. Ricardo, D. (1817). On the principles of political economy and taxation. London: John Murray.

5. Stam, E. and K. Wennberg (2009). The roles of R&D in new firm growth. Small Business Economics 33(1), 77–89.

6. Vivarelli, M. (2014). Innovation, employment and skills in advanced and developing countries: A survey of economic literature. Journal of Economic Issues 48(1), 123–154.

7. Marcolin, L., S. Miroudot, and M. Squicciarini (2016). Routine jobs, employment and technological innovation in global value chains. OECD Science, Technology and Industry Working Papers No. 2016/01, OECD Publishing.

8. Peters, B. (2004). Employment effects of different innovation activities: Microeconometric evidence. ZEW Discussion Papers No. 04-73, ZEW - Center for European Economic Research.