ATPS-Tanzania

The Utility Value of Research and Development (R&D): Where does Tanzania Stand?

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INTRODUCTION

Investments in research and development (R&D) are currently being taken as one of the major measure of levels of innovativeness of companies and countries in general, and by implication, socio and economic development. While the positive relationship between investment in R&D and social and economic development can not be denied (most countries that commit a remarkable proportion of their GDP to R&D are the rich ones), the direction of causality is very much questionable. **Does investment in R&D bring socio and economic development or richer countries tend to spend more on R&D?**

From the behavior of poor countries, including the least developed countries such as Tanzania, it seems it has been taken for granted that the direction of causality is from R&D to wealth creation – that in order to be rich, or at least alleviate poverty - a country has to first invest in R&D. This is revealed by the fact that these countries, poor as they are, are trying to match R&D investments of the richer countries. The evidence for this tendency can be found in various development goals and plan of actions of these countries. The first evident is the Lagos Plan of Action where African countries agreed to Commit funding of R&D activities to a minimum of 1% GDP in 1980, rising to 3% GDP by the year 2000 (to match commitment made by developed countries). However, to date – ten years beyond the target year - not only that the target has not been achieved, but many of the countries have not been able to achieve even half of the starting point of 1% that should have been achieved 30 years back. Tanzania deserves a bingo here: not only that the president finally announced the commitment of the magic 1%GDP to R&D for 2010, but actually allocating it – even if just close to the figure. **Here we raise another important issue of optimality: how much R&D is enough, and what determine this optimum value?** It is not the intention of this brief to address this very crucial question but rather to address the confusion in the direction of causality between investment in R&D and socio and economic development – although in the process the question on optimality will become much clearer. **The intention is to inform policy debates and decisions in the area of investment in innovation and R&D activities in Tanzania**.

Our point of departure is to define R&D, and give a brief historical account of how science and technology (S&T) co-evolved - science being defined as a branch of knowledge or study dealing with a body of facts or truths systematically arranged and showing the operation of general laws of nature, while technology seeks to make practical devices for human use.

WHAT IS R&D?

The Concept of R&D –sometimes mistakenly interpreted in Kiswahili as "Utafiti na Maendeleo" - is made up of three distinct and yet interrelated types of research. First is what is called *basic research,* where research is conducted, normally at the institutions of higher learning for the purpose of general new

knowledge generation (no foreseen immediate use of this knowledge in social and economic development). The second type is *applied research***,** where research is focused towards application to solve currently existing social and economic problems. A good example here is research targeted towards finding vaccines and cure for AIDS. The last type is a research focused on *product development*. Giving the example of cure for AIDS, at the stage of product development all the scientific uncertainties have been resolved, and the focus of research is on how to actually develop the drug or vaccine. The three types of research are interrelated and thought to be a continuum of research towards new and/or improved products and processes development. At each stage in the continuum, including the development of a product/process, a major scientific problem can crop up, and the resolution might require going as far back as to basic research to re-investigate scientific principles in use. This is the reason why **a carefully thought out balance between investment in basic and applied research is always very crucial.**

R&D is not an end in itself, but means to an end**,** especially for the countries that do not have luxury of investing in research for the sake of increasing stock of knowledge. Investments in R&D, where it originated, was meant to spur innovative activities in the productive sector; and this is the reason early R&D activities in the North started in industrial laboratories to be close to production**:** Here we assume we all understand the fact that innovation is a corner stone of social and economic development and wellbeing of nations through widespread development and use of new processes, products and services. **Non-innovative companies and countries can not even *survive*, leave a lone *catch up* and *lead* in currently very competitive globalised environment**. The most striking evidence of the wider impact of innovative companies in the industrialized countries is increase in per capita income, which has increased almost tenfold in the space of two centuries. What is even more important is that this purely quantitative indicator has been accompanied by other indicators of social well being such as longer life, lower infant mortality, eradication of certain diseases, higher level of education, more rapid means of communication, better living and working conditions, greater social protection, more leisure opportunities, etc

RELATIONSHIP BETWEEN INNOVATION AND SCIENCE

i) To What extent is Innovation Exclusively from Science (R&D)?

The European Community Innovation Surveys (CIS) indicate close to 50% of innovative companies do not have to conduct formal R&D to be innovative. Much of their sources of innovative ideas are through interacting and learning from diverse other actors, including – and especially demanding customers, both nationally and internationally. Through these interactions technologies have been upgraded and new ones devised (innovation); and where R&D was used, it was to inform the process of upgrading or improvement in technology.

The above interaction between scientific research and technological change is historical, and the two co-evolved; and it is technology that came first, where improvement in technology (innovation) dates as far back as human civilization. The early improvement in technology took place without inputs from formal scientific research, developing through tinkering, combined with imagination to produce many marvelous devices.

ii) Innovation and Co-evolvement of Science and Technology (S&T)

However as both science and technology expanded rapidly in the recent past, they have come into contact more often, influencing the growth of each other, and seen as an "*indivisible pair*" termed as S&T, with technology mistakenly considered as the dependant partner with science informing technology. It is believed that science predated technology, and technology being simply conceived as application of science. However, as earlier mentioned, history tells us a different story - actually an opposite one - that technology antedated science by far. It has been written many times that it is technology that gave birth to early scientific investigation. It was the working of steam engine as a technology that led to the new field of thermodynamics in science. In chemistry, the science of polymer that emerged in the twentieth century, in large part resulted from informal research performed inside industrial laboratories through trial and error to develop materials that could better fulfill the changing requirement of industry. The rise of scientific understanding supporting aircraft design reflects a similar story: a primitive version of the aircraft (technology) came first and the science discipline of aerodynamics followed.

What we gather from above is that it is human ingenuity through improvement in technology that brought about current unprecedented development in science, and not the other way around: As technology became more sophisticated and required more inputs from science, countries and companies have invested more in science. It is no accidental that among the top world spenders on R&D are those countries with fair share of high tech sectors, e.g**.** Automobile and electronics-Japan; Pharmaceuticals-USA; IT hard ware-German etc.

Historically, as a result of the emergence of high tech industries during the second half of the 19th century, formal R&D departments in companies in developed countries started emerging, and companies started investing in R&D, levels of which were determined by the level of complexity and sophistication of technologies in use. This trend is still obvious even today: **countries and firms are at different levels in innovativeness, and their requirement for formal R&D in the innovation process is therefore also different.** Two major groups of countries can now be identified:

i. Those countries where innovations to a large extent depend on imitation and minor technological improvement, where formal R&D is normally not required: Innovation is achieved through tinkering or learning by doing; and where R&D is used, it is to assist in the tinkering; and in most cases has to be close to production, e .g R&D units in companies. Example of Japan is instructive here. Japan for instance started industrialization through import of foreign technology, integrated this into R&D and production departments. The Japanese R&D during this era, termed as catching up period (1945-1972) was largely on adaptive technology

ii. Those countries that are capable of generating and putting in practice new technologies (products and processes). Here R&D is normally a part. Investment in R&D by both the country and companies therefore a must.

Just like historical co-evolution of technology and science, countries have

built innovation capabilities systematically from the bottom (imitation and adaptation) to top (development and marketing of radically new products), increasingly requiring more science inputs into the innovation process - alongside this, investments in R&D have increased tremendously. **To a large extent therefore market has been a guiding principle in the increased investments in R&D**. The role of the governments has been to correct market failures in this through incentives, subsidies, sometimes even grants and actual investments for instance in basic research where economic incentive is minimum.

iii) What is the Position of Tanzania in the Innovation Capability Ladder and what are Important Issues?

Tanzania belongs to the first category as far as innovative activities are concerned; investment in R&D should therefore be to assist in the process of learning by doing: It makes much more sense to invest more in technology upgrading than formal R&D in order to enable existing firms and farmers to systematically build their innovation capabilities. Technology should therefore be put first rather than science; **because without technology science is meaningless as far as socio-economic development is concerned** – the abbreviation S&T in this case would have been T&S. The simple reversal of letters in this abbreviation would have made a remarkable impact in the way science, technology and innovation policies are designed and evaluated in least developed countries – at least policy makers would have understood that technology comes first, and the **focus of the S&T policies to be more on technology and producers, rather than on science and researchers; and the technology (current and potential) to determine what science, and how much investments to be made.**

The current superiority of science over technology is not without history: it can be traced back to the success of the World War II military science, especially the Manhattan Project that created the atomic bomb – the most destructive weapon ever made in human history. As a result science was taken to be an endless frontier, and that all governments needed was to invest more in science. This notion actually influenced early S&T policy making in the US; and it seems most countries subsequently copied this US model. However things turned around as soon as the developments in military science trickled down to the civilian technology – demand for new products and processes, and not science, became more important in driving innovation.

Following the above realization, most countries have now changed the way they design and evaluate their innovation policies, largely integrating R&D with actual or potential demand for new products and processes. Exception is the least developed countries such as African region. Ironically these are countries where most technologies in use are still far less science intensive, where improvement in technology is still based on learning by doing rather than being informed by formal R&D. But, **very unfortunately, where we needed science to inform technology upgrading in firms and farms, S&T policy focus has largely been on science per se**

The above is not to argue that Tanzania should refrain from investment in R&D to support high tech companies that currently do not exist in Tanzania; to the contrary, Tanzania should very seriously think of the strategies to ensure the emergency of such companies, especially in the areas where it has comparative advantage such as those in responsible for value addition in natural resources such as energy and mineral exploration and processing. In parallel to the investment in R&D for technology upgrading therefore, investment must be made in R&D that support the emergency

of such high tech companies, but realistically seeking market niches and/or stimulating demand through demand side innovation policies - innovation to a large extent is demand driven. This can be through instigating and supporting spin-off companies, especially from R&D and higher learning institutions. **And it is the demand side innovation policies that can be helpful in these, rather than traditional supply side innovation policies.**

Finally, and the whole purpose of writing this policy brief is the following million dollar question: **What would be the ultimate goal of allocating 1% of GDP to R&D? Is it the same purpose of influencing innovativeness of firms and farms? Or is it just extending the frontiers of scientific knowledge?** If the purpose is innovation, what proportion goes to technology upgrading (to assist the current producers, both in industrial firms and farms) and how? What part goes to product development aspect of R&D and Spin-off companies? Which sectors?

The product development aspects of R&D and support to spin-off companies are particularly being mentioned here, not because we think the other parts of R&D are not important, but because these are the most neglected parts of R&D in most African innovation and R&D policies. Remember that in economic terms, R&D expenditure is simply an overhead expense until the results are commercially exploited through their application in the production processes. In this regard, **unless the promised 1% of GDP to be committed to R&D is used wisely, we may end up much poorer.** In this regard, a recent move by the government of Uganda is worth applauding for: According to SciDev.Net, Uganda has allocated extra money to near-market research: A total of US$540,000 will go to the Uganda Industrial Research Institute and around US$2.2 million to Makerere University, in Kampala. A further US$450,000 is allocated to Enterprise Uganda - a fund supporting entrepreneurship; and US$1.8 million will feed into a venture capital fund to support start-up companies aimed at university and college graduates.

Returns to innovation are both long and short terms. They are short term for technology upgrading; but the returns can be long term for establishing new high tech companies. Which so ever the case, **what can take Tanzania out of poverty is not the traditional supply side innovation policies that to a large extent are informed by the linear model of innovation that put science first, but rather the demand side innovation policies that put the producers and their technologies (current and potential) first.**

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