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VIEWPOINT PAPER

Benefits and Costs of the Science and Technology Targets for the Post-2015 Development Agenda

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Post-2015 Consensus

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Introduction[1]

Articulating the role of technology in the post-2015 discourse on sustainable development goals (SDGs) discourse has not been an easy undertaking. The complexities involved can be traced back to a few, but critical, issues of technology, innovation and development. Technology and its role in overall development of countries still remains a highly argued topic in international, regional and national debates. While its ubiquitous role in promoting overall industrial development and structural change is well acknowledged in theory and practice, there are divergent perspectives on how technological change can be fostered in the context of developing countries and what the role of external technology transfers in this context can be. Furthermore, technology has often been considered as a means of achieving another goal, rather than the goal itself. This latter issue was clearly manifested in the process of elaborating the UN Millennium Development Goals (MDGs), where technology was primarily set out as a target within other goals and targets, such as Internet and communication technologies and combating HIV/AIDS. In more recent times, there has been an emphasis on tackling technology issues within particular sub-themes, such as climate change or public health.

While this bias on dealing with technology as particularly application to climate change, energy and sustainable development is also visible in the earlier dialogues of the SDGs agenda, over time the SDG documents show that the debate on the post-2015 SDGs has evolved to afford technology issues much more attention in a broader, developmental perspective. An astute review of the SDG documents in the post-2015 discourse shows traction towards a two-dimensional articulation of the role of technology. On the one hand, technology is still considered as a means to provide certainly essential global public goods; and there is still often a tendency to treat technology in terms of elaborating how it can be used/ facilitated to accomplish other goals.[2] But at the same time, the Outcome Document of the Open Working Group (OWG) for Sustainable Development Goals of 19 July 2014 has set out at least two goals (goals 8 and 9), which clearly capture the central role of technology for overall growth and development of nations, namely: (a) the sustained, inclusive and sustainable economic growth and (b) in promoting sustainable industrialization and fostering innovation.[3]

A closer review of the Open Working Group (OWG) Document dated 19 July 2014 shows that goals 8 and 9 encapsulate the key role of technology in overall development. Goal 8 summarily provides for the role of technology in the form of technological upgrading and innovation, job creation and enterprise growth. Goal 9 elaborates upon technological capabilities through scientific research and increased innovation through greater R&D and greater public and private R&D spending, domestic technology development through a

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[1] The views contained in this paper are the personal views of the author only. I am thankful to Pedro Roffe for comments on an earlier draft of the paper.

[2] See for examples, documents such as UN Working Group, "Introduction and Proposed Goals and Targets on Sustainable Development for the Post-2015 Development Agenda", 02 June 2014.

[3] See UN Working Group, "Introduction and Proposed Goals and Targets on Sustainable Development for the Post-2015 Development Agenda", 19 July 2014.

conducive policy environment. Both these provisions together acknowledge the overall critical role of technology for innovation, industrial development and overall prosperity of nations.[4] In a bid to strengthen this further, goal 17 of the OWG document calls for a global technology facilitation mechanism. Apart from these broader articulations of the role of technology for overall innovation and industrial development, technology and technology transfer are elaborated upon in the context of provision of some global public goods, particularly energy (goal 7a and 7b), access to internet and communication technologies (goal 9c), transfer of maritime and ocean technologies (goal 14a) and environmentally sound technologies (goal 17.7), among others.

However, the eventual success of each of these goals will ultimately depend on how these are implemented through targeted interventions and what milestones will be set for their implementation.

Against this background, the Challenge paper on this topic tries to view the viability of two specific technology objectives (which I will call incentives in this paper), namely:

(a) Promote industrial research and innovation by raising the ratio of R&D workers per one million people by X% and the share of R&D spending in GDP by y%,

(b) Establish ten-year visas permitting free mobility of skilled (technical and managerial) labor among participating "innovation zones" in an effort to optimize technology, diffusion, efficiency and learning among enterprises within such zones.

Broadly speaking, both these technology incentives can be linked to the final report of the Open Working Group dated 19 July 2014. Whereas objective 1 of the Challenge paper can be linked to the 02 June 2014 document of the UN Open Working Group[5], the second objective could be possibly used as a sub-element of the technology facilitation mechanism that is described in Goal 17.6 of the Proposal of the UN Open Working Group of 19 July 2014.[6]

However, there is a need to view the issues that are analyzed in the challenges paper more broadly in the context of the global political economy of technology negotiations and discussions, as well as development studies and development economics. My paper will try to consider these issues at some length from these perspectives to offer some additional viewpoints to the challenges paper.

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[4] See for example,
http://www.un.org/en/development/desa/policy/untaskteam_undf/thinkpieces/28_thinkpiece_science.pdf

[5] This is contained on p.10 of the 02 June 2014 version of the OWG. However, this goal, that has been considered by the challenge paper on the basis of earlier OWG draft proposals, is articulated differently in the document of 19 July 2014, namely: enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, particularly developing countries, including by 2030 by encouraging innovation and increasing the number of R&D workers by x% and public and private spending. The key difference is that a target for increased public and private spending is no longer specified.

[6] This has been proposed in the context of promoting North-South and South-South cooperation on access to science, technology and innovation and to enhance knowledge sharing through improved cooperation.

The two technology policy incentives (which the paper terms as 'technology objectives') analyzed in the challenges paper, are both considered broadly as technology incentives that can facilitate technology development or technology transfer as listed out in the OWG document. To that end, the paper does not differentiate on technology development from technology transfer. This raises one of the core concerns in international debates on the topic: can technology transfer and technology development be considered as similar or synonymous issues? If not, are there any limits to conceptualizing technology transfer? This is a highly relevant issue, because the two concepts are very different in practice. However, political debates on these issues at the international level reveal a rather opaque and vague conceptualization of these terms, which may be highly detrimental to the implementation of goals related to technology in the future. Distinguishing these concepts is also relevant for the challenges paper because the second objective analyzed therein (on the role of tacit know-how exchange in innovation zones) relates much more to technology transfer, if one were to adhere to its traditional conceptualization.

A second pertinent set of concerns raised by the challenges paper relates to the question of methodology. Can issues of R&D spending and its impact on industrial development be modeled, and if so what are the limitations of applying/ deducing the results of these models to real life situations. In theory, modeling these issues might give us some inkling of what are the costs, benefits and how these might interact to achieve results, within certain assumptions. But in reality, most of these assumptions may not hold good in the real world, and particularly, there may be other issues relevant to developmental contexts of countries that need to be borne in mind while considering these results. Development economists and scholars of development studies have shied away from modeling technology issues particularly for developing countries, since these are difficult to pin down in a set of assumptions to obtain results that are widely applicable. Notwithstanding this, if one were to attempt to analyze such issues using partial equilibrium modeling techniques, what would be important points of departure for such research? The following sections seek to discuss these aspects at some greater length.

Technology Development, Technology Transfer and Technological Learning

The development of technology is a critical pre-requisite to foster the process of structural change, which refers to a process of moving labour away from low productivity sectors to those with greater productivity returns in a consistent manner. This process, which is the backbone of industrialization, relies on technological development as a means to increase productivity returns of sectors in the economy. Such technological development, in turn, builds upon technological learning, which refers to the process through which agents learn to use, adapt and create local variations of existing technologies. This is usually the first step in a much longer process of technology development with countries.

Technology transfer can be an important contributor/ facilitator to this process of technology development. However, two important qualifiers need to be noted. It is usually an exogenous parameter: it may be a useful tool, but is not a necessary precondition to promote domestic technology development. As a result, technology development can proceed completely on the backbone of national technological learning and technological upgrading policies, without any specific technology transfer. Furthermore, in order for countries/ agents to effectively use technology transfer locally, there is a need for some level of local technological capabilities that can facilitate these arrangements. Often also known as technological absorptive capacity,[7] the term refers to the ability of local agents to 'absorb' technology to apply it to the local context. In the absence of such absorptive capacity, technology transfer often fails.[8]

Therefore, although technology development and technology transfer are linked, incentives that could promote the two are often different. For example, raising R&D as a ratio of GDP spending is an incentive aimed at overall technological development of a country. If done properly, this can result in raising the capabilities of sectors and the economy of the country to engage in technology-based learning and upgrading, leading to an increase in overall innovation capacity and innovation performance. When countries invest more into R&D and have a greater level of local innovation capacity, it may also attract technology transfer ventures, but this would be a windfall gain. Such a policy change is quite different from others that directly target technology transfer.

R&D Spending and Technological Development

The idea that R&D allows one not only to develop new products, but also improves the ability to assimilate and develop new products and processes is not a new one.[9] In recent times, the surge in science, technology and innovation policies in national contexts has refocused the spotlight once again on R&D targets, R&D policies and their impact on technological learning. The eighth African Union Summit of 2007, for example, called for reinforcing African R&D spending to 1% of total GDP by 2010. Recent figures show that some countries have managed to accomplish this, much ahead of the 2010 targets set out by the summit,[10] but many others have not yet reached the target.

More generally speaking, developing countries are quite heterogeneous and as a result many of them have had, in the past, variable and often difficult experiences with R&D spending. A fundamental problem in many developing countries has been that simply setting R&D targets without focusing on innovation environments often leads to wrongly channeling hard-pressed funds into vague or unconnected activities. This is the result of the fact that such targets often tend to operate as goals in themselves, rather than a means to achieve the goals of the national science, technology and innovation policy frameworks.

[7] Cohen, W. M. and D. A. Levinthal (1990), "Absorptive Capacity: A New Perspective on Learning and Innovation", Administrative Science Quarterly, Vol 35, Issue 1, pp. 128-152.
[8] Gehl Sampath, P. and Pedro Roffe, "Unpacking the International Technology Transfer Controversy: Fifty Years and Beyond", ICTSD Policy Paper Series, Geneva, 2012.

[9] Cohen and Levinthal (1989) who argue that R&D allows firms to exploit information. See Cohen, W. M. and D. A. Levinthal (1989), "Innovation and Learning: The Two Faces of R&D, The Economic Journal, Vol. 99, No. 397, pp. 569-596.
[10] See African Innovation Outlook, 2010 at: http://www.nepad.org/system/files/June2011_NEPAD_AIO_2010_English.pdf

A somewhat related problem has been that setting R&D targets as part of national policies leads to the misleading notion that R&D is the prime factor leading to innovation. Taken in the context of innovation in the industrialized countries and the knowledge economy, one may even be persuaded to consider this, but this is not necessarily the case in a large number of developing countries.

Highlighting the perils of focusing narrowly on R&D, innovation and development studies have stressed for decades now, that innovation is not to be construed narrowly as R&D and inventions, but rather is the ability to convert the R&D results/ inventions into marketable products.[11] Scholars and studies have stressed that technology, as understood as knowledge, skills and means of arriving upon a product or a process is critical to developing innovation capacity[12] and is a gradual process of capabilities accumulation.[13] Fostering technological change is a distinct feature of technology policy, offering different selection processes and different institutional structures.[14] The focus on R&D spending needs to be considered within this prism.

But at the same time, these studies have called for a good public R&D system as critical to bootstrap the enterprise sector, enabling it to engage in assimilating and developing newer products and processes, a fundamental feature of learning, upgrading and technological development. Public R&D has been a staple component of industrial development strategies of most developed countries, and several examples exist to show the critical role of such R&D investments in boosting sectoral performances in countries.[15] In addition to solving the appropriability issue in basic R&D,[16] they also promote greater linkages and collaborative learning through university centres of excellence.

Despite these benefits, in reality, R&D structures (both public and private-sector based) in a large number of developing countries are non-existent, and where they exist, in drastic need of investment in order to make them useful for university and industry alike. Investments into R&D therefore need to be made with significant care and coordination with local innovation environments is critical to reap the benefits from such investments. Furthermore, R&D investments should be accompanied by other incentives, such as R&D tax credits that foster private sector investments into R&D in a complementary way.

While calculating the benefits and costs of R&D spending, the following aspects are relevant:

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[11] Starting from Nelson, R.R. and S.G. Winter (1985), innovation studies of this kind have explored these issues at length. See Nelson, R.R. and S.G. Winter (1985), An Evolutionary Theory of Economic Change, Harvard University Press, 1985.

[12] See fir example, Freeman, C. (1994), "The Economics of Technical Change", Cambridge Journal of Economics, vol. 18, pp. 463-514.

[13] Macmillan M. S and D. Rodrik, 2011, "Globalization, Structural Change and Productivity Growth, NBER Working Paper Series 17143, NBER, Cambridge Mass.

[14] Metcalfe, J.S. (1994), "Evolutionary Economics and Technology Policy", The Economic Journal, 104 (425), pp.931-944.

[15] See for example, Alston, Anderson, et al (2010), Persistence Pays: US Agricultural Productivity Growth and the Benefits of R&D Spending, Springer.

[16] Given the low economic returns, particularly of basic research and often also of different forms of applied research, no one single individual has the incentive to invest in generating this, thus rendering it a public good.

1. At a theoretical level, the costs of increasing R&D, as mentioned in the challenges paper, include typically (a) a fiscal cost to the government of paying the increased public expenditures (from offering public sector R&D) and lost tax revenues from offering tax credits (to the private sector); (b) efficiency losses to the economy by moving skills away from other productive activities to R&D (which may or may not reap benefits) and (c) cost to the government of implementing the programs. In addition to these three costs, if R&D programs are to reap benefits, the government has one more cost, namely, the cost of implementing and coordinating a well-functioning innovation policy framework since R&D programs and their impacts accrue only within the broader parameters of innovation capacity. There are two benefits of R&D programs, viewed thus, namely: (a) spillover productivity gains to the economy, and (b) additional innovation that is generated through these spillovers. These two gains, however, only accrue when there is a well-functioning innovation environment, and therefore foreseeing and in-calculating a fourth cost related to the innovation environment is critical.

2. Modelling the impact of R&D spending on economic outcomes, particularly R&D spillovers, productivity increases and competitiveness is extremely difficult, if not impossible because to model it accurately, one would have to take on board several factors which have long-term implications, or are country and context specific.[17]

3. Even if we were presented with such a model that took on board all of these costs and benefits, it is difficult to make assumptions/draw conclusions on a general basis that it may not be beneficial to in developing countries. Particularly, the following caveats should be considered:

(a) R&D based spending may lead to variable productivity gains in different contexts. In all developing countries, making an assumption that R&D laboratories leads to higher productivity through acquisition of internationally advanced technologies might not hold good, since the enterprise sector in a large number of developing countries are at a level where learning is not directly R&D related as in the OECD. Furthermore, there is a need to distinguish basic R&D from applied R&D and the relative gains to productivity from uptake of these results in industry.

(b) The impacts of R&D credits depend on the country/ sector context and also on the type of credits. Studies that directly look at R&D credits in developing countries may not exist, but studies of a similar nature do exist in some developing countries and these could be considered.[18]

(c) Such an analysis needs to include an elaboration of the kinds of incentives that should be included in the incentive packages to ensure the substantial increases in R&D ratios in different kinds of developing countries, since once again, the different incentives may

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[17] See Stiglitz, J.E and B. C Greenwald, Creating a Learning Society, Columbia University Press, New York. The impact of R&D on ultimate R&D spillovers, productivity and rise in competitiveness is hard to measure in countries, even within the OECD (Koehler et al, 2012 cited also in the challenges paper).

[18] For example, Emre Ozcelik and Erol Taymaz, R&D support programs in developing countries: The Turkish Experience, Research Policy, Volume 37, Issue 2, March 2008, Pages 258–275.

produce different set of discrete results in R&D based spillovers in different country contexts.[19]

(d) The challenges paper includes higher education as public research expenditure. Higher education should not be considered as government research expenditure. Tertiary education may be counted as research expenditure perhaps, but including higher education as research expenditure is misleading and obfuscates one of the biggest problems in developing countries, namely the low governmental investment into industry-relevant research and development programs.

(e) R&D expenditure is rarely split between government and private sector on a 50-50% basis in the developing world as is assumed in the model in the challenges paper. Furthermore, an important issue is not the R&D expenditure per se, but rather the returns on expenditure and the R&D priorities and their suitability to industry needs. Also oftentimes, applied R&D is conducted within enterprises and not by the public sector in developing countries, but this is supported through governmental grants. Therefore, a systematic assessment of the current status on these issues in the developing world should form part of, and inform the results of, such a model.

(f) The benefits of public subsidies to R&D, namely, spillover productivity gains to the economy and other gains from such spillovers going forward in addition to the target R&D – both result only when such R&D results are taken up by other agents in society for commercial innovations (in the form of products and processes). But this depends on the government's investment into the general innovation infrastructure/ environment or the costs of the enterprises to overcome innovation constraints to uptake research results and apply it to achieve productivity gains.

Furthermore, while expounding on the impact of R&D on technological development, some other particular issues that come to mind are:

(a) If countries were to increase their share of R&D spending as a % of GDP, how would it help them to gain more from technology inflows through trade, investment or technology transfer?
(b) How can this increase be harnessed into increased innovation rents?
(c) How can one eliminate the inefficiencies/ inadequacies in the current R&D investments in public-private sector R&D in the developing world.

These issues would need to be addressed more systematically as part of future research.

[19] This seems pertinent, since developing countries are at relatively different levels of innovation capacity, and some kind of variable analysis between emerging developing countries, other developing countries and least developed countries is really important to nuance such results.

Technology Transfer through Tacit-Know How Exchange in Innovation Zones

Innovation zones that permit free circulation of skilled labour are a novel idea that could be considered as part of a technology facilitation mechanism. Technology transfer literature has emphasized since long that it is highly relevant to consider tacit know-how exchange, perhaps far more than simply the exchange of machinery and equipment, to ensure successful technology transfer.[20] While considering the creation of such innovation zones, the following research and policy issues may be useful.

A first consideration should be to differentiate the impact of migration of skilled workers in different developing countries. Migration is welfare enhancing at the global level, and also to the migrant workers. However, in calculating the benefits to any particular developing country, it would not be appropriate to consider that when migrant workers leave the productivity area where they work in the developing country, there are other skilled workers in the countries in question to occupy this area (see figure 1 of the paper and associated explanation in text).

If this is true, then so long as the remittances from the movement of the skilled workers are greater than the opportunity costs induced by their movement to another country, it is beneficial for the home countries. In reality, this would be the case only when the home country has other skilled workers who can serve as perfect substitutes for those who migrated to the destination country. While the model in the challenges paper considers the issue that the migrants should be perfect substitutes of other skilled labour available in the destination country, the model does not acknowledge that the home country needs people who can also be perfect substitutes to occupy the spaces created in the labour market by the migrants.

This is a very relevant issue in applying this model or its results. Most developing countries do not have skilled labour that can replace those who migrate to developed countries or other more advanced developing countries. Therefore, although they receive remittances, which help to speed up development, they suffer from a loss of competence to build their economies, promote learning and boost technological learning. The lack of skilled personnel is crippling in that context, and retards developmental prospects (since remittances are used to send more people to school, but it takes decades until those who are being schooled can join the workforce).

Another set of issues that more research is required upon is how to measure the technology transfer that occurs through the migration of workers as part of such innovation zones. Currently, while not defined as such "innovation zones", there are hubs of innovation excellence that routinely attract highly skilled migrant workers, and there are tacit technology spillovers through their returns to their home countries, or other forms of

[20] Arora, A., The Transfer of Technological Know-How to Developing Countries, Stanford University, 1991; David, Paul A., 1993, Intellectual property institutions and the panda's thumb: patents, copyrights, and trade secrets in economic theory and history, in: M. Wallerstein, M. Mogee and R. Schoen (eds.), *Global Dimensions of Intellectual Property Protection in Science and Technology*, National Academy Press, Washington, D.C.

tacit know-how alliances on a day-to-day basis. However, economic indicators are usually unable to measure these knowledge flows, and they remain largely unaccounted for in technology transfer assessments and reviews. While there is some research on how to rope in the diaspora for the creation of knowledge networks in home countries, more research is required to see how these knowledge exchanges can be made more fruitful between and among countries and agents.

Concluding Remarks

The goals outlined in the Outcome Document of the Open Working Group of 19 July 2014 are a very useful and important first step in highlighting the relevance of technology, technological upgrading and technology development to building innovation and fostering industrial development, and also to harness the relevance of technology towards some important developmental goals. However, these are not standalone goals that can be implemented to measure periodic progress on their own. Their success will depend upon the elaboration of mechanisms and incentives that can be supported by a policy roadmap that sets out clear milestones to help countries to realize their beneficial impacts.

The strength of the outcome document is that it provides sufficient policy space for country-based adaptations. How this can be utilized while designing the incentive mechanisms on each of these goals remains to be seen. A further challenge for countries is to align themselves on the nature and purpose of the incentives and mechanisms to implement the goals. Some of the current proposals, for example, the technology facilitation mechanism, have evolved from being proposed just in the context of climate and energy technologies, to broader instruments for overall technology facilitation in all sectors as they stand in the final outcome document. How this is taken forward remains to be seen.

This paper has sought to raise some issues in relation to considering the impacts of technology development, technology transfer and innovation capacity in this regard. It has also tried to provide some perspectives on how the mechanisms analyzed and proposed in the challenges paper could be used in the elaboration of incentives and mechanisms based on the Final Outcome Document. More research, particularly substantiated by country-level data and informed discourse on these lines will help to ensure a promising post-2015 agenda on this highly critical area of relevance to development and prosperity to all countries, but developing countries in particular.

This paper was written by Padmashree Gehl Sampath, Chief, Science and Technology Section, UNCTAD. The project brings together more than 50 top economists, NGOs, international agencies and businesses to identify the goals with the greatest benefit-to-cost ratio for the next set of UN development goals.

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