Seizing Opportunities for National STI Development

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Science, technology and innovation (STI) is broadly assumed to be among the main drivers of change in contemporary economies and societies. Accordingly, it is recognized and accepted that STI contributes to addressing national challenges and problems. But this raises an important issue: does framing matters in terms of challenges and problems providing an effective way of mobilizing resources? This sort of framing may actually be productive in some circumstances, for some stakeholders, but less so in other contexts and with other agents of change.

In particular, there is a certain concern with how scientists and engineers perceive research. Typically, they are ambitious in their efforts to solve a problem. Thus, initially they describe and decompose the problem to uncover all its possible facets and fully understand it. An activity to solve the problem follows in the tradition of scientific work. This approach is targeted at directing efforts to each feature of the problem and finding a solution for this. Each solution to the sub-components of the wider problem is in most cases treated independently, without being incorporated into an overarching consistent system. The reason is that problems are now typically larger in scale and more complex compared to just a few decades ago. This means that many scientific working groups must cooperate to solve challenges and issues, even though these teams usually compete among themselves (Gokhberg and Sokolov 2013; OECD 2011; Schibany and Reiner 2014; Meissner 2015).

This practice of scientific work is undoubtedly productive for understanding problems and developing new knowledge. However, the results are very sophisticated and specialized which means that their ability to be integrated into broader systems is limited. It is broader systems indeed that are in demand for solving the broader challenges. In this respect, there is a clear need to shift in the ways how we

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perceive and solve problems. 'Thinking in Opportunities' instead of 'Thinking in Problems' is not only a play with words but has practical implications of a strategic nature.

'Thinking in Opportunities' implies that an issue is treated in a way which specifies the requirements for a potential solution. These requirements are matched against existing solutions which might be appropriate to solving the problem. The next step is analyzing the gaps which arise from matching requirements and potential solutions, and further decomposing these gaps into smaller issues and related solution requirements until it is possible to clearly formulate research projects and plans to solve the overarching problem. A special feature of this 'solution-driven approach' (also called the 'opportunity-driven approach') is that from a very early stage the interfaces between different features and components of the overall system are considered. However, any challenge or problem is unique and consequently the solutions are varied. Hence the 'Thinking in Opportunities' approach that we have outlined here may be applied broadly but it needs to be elaborated in much more detail, particularly for the purposes of designing an STI policy mix or corporate strategy.

Opportunity-driven thinking is a widespread motivation for company innovation activities. Therefore, a problem **and** opportunity analysis is a more widely used instrument in innovation management and business development than in scientific communities. Another challenge however is that solutions—and hence innovations—vary not only in shape (product, process, service, business model etc.) but also in the underlying competencies required for a given application or technology field. While the same sources of innovation (whether that is the science and research base or commercial entities) pertain, their relative weights are changing. Opportunity thinking requires a stronger orientation to applicable solutions rather than the approach which aims to more fully explore a problem ('problem thinking'). Therefore the requirements of users for a solution (e.g. the companies who possess the competencies to identify and address certain problems) gain more weight as sources for innovation, compared to the science and research base (Brown 2003; Geroski 2000; Reed et al. 2009).

Consequently, the share of pull innovation increases while that of push innovation decreases. Solutions to meet challenges or solve problems are however more about push innovation by nature than the pull one because a user of the innovation is not necessarily known to anyone at the current stage. Therefore, a mixed STI policy approach is reasonable as it would reconsider the balance between different innovation sources in light of the specific characteristics of the challenges. The interfaces between different individual solutions which need to be integrated into complex systems require more careful elaboration in the early phases of STI policy design in order to develop a smooth and seamless STI policy mix (Gokhberg and Meissner 2013; Meissner 2014).

'Thinking in Opportunities' in fact is very different from the 'Thinking in Problems' approach because it predominantly looks forward and is concerned with creating innovations. In contrast, the problem-solving model mostly addresses existing systems and thus often looks backwards (i.e. it addresses problems of the past).

The opportunities-orientated approach fits much better with the nature and contents of foresight studies, in particular in the field of STI. Taking account of multiple factors that impact potential catching up opportunities and a broad spectrum of relevant research problems, this approach—at the national level—creates a backdrop for launching large-scale, complex STI projects that can be funded i.e. through public-private partnership schemes (Gokhberg and Meissner 2013).

Nevertheless, this new paradigm for STI policy applies to all countries irrespective of the developmental status of their National Innovation System (NIS) (Meissner et al. 2013). We are used to hearing that to become or remain globally competitive, countries need to boost national innovativeness. However, this simple formulation is liable to be counterproductive, if we do not disentangle what is meant by 'competition'. Policy measures aimed at increasing national competitiveness need to consider the different dimensions of competition, among which the following are central to STI:

- **Global industrial competition** is the traditional competition faced by companies for the best solution to user requirements at the best price; for some authors the only form of competition is that between companies, but in reality the next two categories of 'competition' are often also brought into play.
- **Global science and research base competition** is frequently understood as the international competition for the outputs from science and research. Recently, international *competition for talent* has become more intensive as an increasing numbers of countries have begun to promote their national STI systems to achieve, first, excellence in science and, second, excellence in innovation. This has led to an intensified *competition for favorable research and innovation environments* to make the NIS attractive for talent and investment both globally and domestically. It mainly targets the relevant framework related policy instruments, including labor and migration laws and tax incentives, as well as major STI support mechanisms such as funding and remuneration schemes, etc.
- **Global competition of countries** leads to efforts to design the best possible framework conditions for entrepreneurship and innovation which are often generous, in particular towards companies' investment in national STI related activities.

To increase the efficiency of national economies and STI systems, most countries have been developing national innovation strategies. These strategies frequently involve STI priority setting, smart specialization, public-private partnerships, mechanisms promoting industry-science linkages, cluster policies and technology platforms, tax credits and other subsidies, as well as earmarked measures to attract and keep talent. Setting priorities for STI is one of the most burning issues for national governments. Frequently, foresight is used to identify and set up related priorities. However, foresight often has a rather narrow focus on STI, neglecting societal and environmental developments (Georghiou 2013; Simachev et al. 2014; Kasimov et al. 2015).

Although many countries have—at least partially—developed and implemented national STI strategies, these strategies are increasingly challenged. In any strategy, there are always winners and losers in a NIS, and political establishments play an important role. STI strategies in particular have been often perceived as suitable policy initiatives by policy makers who have very personal agendas. Moreover, the political establishment in most countries is characterized by the competition for influence between national entities (ministries, agencies, councils, etc.). For example, national and regional institutions might not follow a shared ambition and vision which ultimately limits the possibilities for a coherent and consistent strategy. In addition to challenges in developing a strategy, implementing national STI strategies is often difficult. Although top-level policy initiatives create a certain momentum among STI actors for some time, the actual implementation of policy actions (either designed in the national strategy or derived from the strategy's overarching directions) is usually left to subordinated agencies. In this regard, experience shows that the more agencies are involved in implementing STI, the less stringent and sustainable the implementation of strategic measures is. The reason for this is the different perceptions and interpretations of strategies by the implementing agencies, which is at least partially due to their respective roles and duties.

National STI strategies need to take into account the potential future developments of society, industry, science and policy under a variety of possible scenarios. The latter are important because countries' stated priorities often alter when the leadership and/or socio-economic conditions change. An important determinant for the successful implementation of STI strategies is the institutional organization of the NIS. In principle, the organizations making up the NIS should follow the main strategic intentions. For example, the strategies require complementary institutional adjustments. Moreover, the institutions' structure alone does not guarantee a desirable impact and success; instead, the success requires communications and education of the people involved as well as near time operational measures to maintain the initial momentum (Gokhberg 2013; Meissner 2014).

Ultimately, a STI policy mix which follows the opportunity thinking approach and tackles challenges needs to look beyond its traditional elements. *Competition and trade policies* need to work in tandem to discourage rent-seeking behaviour and help economic actors in accessing global markets and communities. *Finance and investment policies* should focus on supporting financial institutions that are able to properly value innovation-related investment. In addition, this includes supporting the efficient management of some of the risks inherent to smart specialization and resulting innovation within specialized clusters. *Education and training policy,* together with *labour market policy*, should help secure the quantity, quality and efficient allocation of human resources, while *research policy* needs to be targeted at developing and mobilising mutually reinforcing research capabilities in the public and private sectors. *Industrial and regional policy instruments* need to develop and maintain an appropriate infrastructure and other support mechanisms to realise the innovation potential of specific sectors. *Social and health policy*

should consider innovation as a means—as well as a result—to improve the quality of life. *Environmental policy* views pro-innovation regulations and incentives as important tools to encourage value-creating responses to the sustainability challenge. Finally, *legal policy* exists to enforce the rule of law, protecting intellectual property rights and broader innovation activities that are already inherently risky against additional, unbearable uncertainties (European Communities 2002).

These policy fields require increased and improved interaction to ensure sustainable functioning of the NIS. It is common for these policy measures to be developed and implemented by dedicated governmental agencies. In most cases, the different policy measures do not fit together well. They are designed towards piecemeal objectives of various public agencies and usually made at different times, which can also be counterproductive to a coherent STI policy mix. A coherent STI policy mix that 'supports opportunities' demonstrates a number of characteristics, namely:

- It adheres to an anticipatory model to address the most essential, systemic failures and leads STI advancement and utilization to contribute to economic growth, inclusiveness, and green/sustainable development including a strong commitment to support STI in the sectors that are important to enhance competitive advantages at national and regional levels, to stimulate youth creativity, and are prepared to pro-innovation attitudes.
- It recognizes that national STI development is a long-term undertaking which also requires significant improvements in national STI strategies including forward looking priority setting and the governance system.
- It emphasizes the regular use of foresight and allied strategic intelligence tools which take account of industrial, technological, and scientific developments, market and application field-specific trends, as well as significant STI and related policy process developments, thereby stressing the implementation of foresight in national STI strategies and the succeeding development and implementation of STI policy measures.
- It elaborates national STI strategies with special emphasis on partnerships which are required to establish the balance between basic research, applied research, and commercial interests to assure a reasonable pipeline for innovation in the future. In this respect, competing values of potential partners are involved which have to be accounted for and the respective incentives set for partners to disclose their related strategic intentions and limit (or even avoid) the rent-seeking interests of individual partners.
- It broadens the traditional linkages between NIS actors, e.g. the collaboration and partnership paradigm, by considering the existence and the power of global STI networks and the global value chains of industrial sectors, hence involving horizontal and vertical linkages between the actors.
- It reflects on the role of public authorities (such as regional or national governments and affiliated bodies) as coordinators and also players in enabling the process of entrepreneurial discovery and in designing public or semi-public institutions, setting framework policies and standards affecting technological attributes, user demand and other market factors in designing industrial policies;

- It creates awareness among researchers in universities and public research institutes about research management and strategic research orientation, especially an awareness of the relationship between results and applications, and commitments to open communications with the society and partners, which determines the quality and design of information, communication and decision-making processes.

The implementation of policy initiatives requires effective governance, which in turn often leads to emerging skills and training needs for employees of regional and national governments. Furthermore, it is essential to have a close interaction regarding STI policies and implementation measures across the different levels in a country to assure coherence between innovation strategies at different levels, 'translate' regional choices into terms used in the national strategy, and reach the targeted STI community in a country to achieve the intended impacts.

Ultimately, the design and implementation of a consistent and coherent STI policy mix which clearly addresses the features of 'Thinking in Opportunities' is crucial for countries to generate momentum and take advantage of the full potential of STI.

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