# FTA FOR RESEARCH AND INNOVATION POLICY AND STRATEGY

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### Abstract

The paper addresses the application of FTA to research and innovation policy and strategy. Drawing upon past FTA Conference papers and recent developments it seeks to show an evolution away from a traditional focus on broad-based technological priority setting to a much more focussed and adapted set of applications. The inherent limitations of prioritisation processes are discussed. The more limited aim of articulating specific fields is noted. An increasing structural focus for FTA exercises is associated not only with broader R&I system reform but also with an engagement with new-wave innovation policies. The success of demand-side measures such as cluster policies and the use of procurement or regulation to stimulate innovation is dependent upon the formation of a common vision between the supply and demand sides, opening the possibility for the application of FTA approaches. We note the emergence of a combination of corrective, disruptive and creative roles.


### Introduction

The predominant focus of FTA[1] is frequently national research policy and strategy, usually with the broad aim of selecting priorities for research investments. The early Japanese Delphi exercises were mainly applied in this context and helped to shape the international understanding of the function of technology foresight as having a role in priority setting.[2] IT remains a key application for large Delphi exercises as witnessed by the recent Chinese survey.[3] FTA is also used to inform or reform innovation policy and strategy, an activity which sometime ago called "wiring up the innovation system".[4] In recent years there has been growth in FTA for regional innovation and economic development (see for example the FOREN Guide[5]) with a stronger emphasis on indigenous strengths and tapping local tacit knowledge. There is also evidence of growing efforts to bring research and innovation policy and strategy together and use of FTA for more joined-up policies and defining the

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[1] Technology Futures Analysis Methods Working Group, Technology futures analysis: Toward integration of the field and new methods, *Technological Forecasting and Social Change*
Volume 71, Issue 3, March 2004, Pages 287-303

[2] Kuwahara T, Cuhls K and Georghiou L, Foresight in Japan, in Georghiou L., Cassingena Harper J., Keenan M., Miles I., and Popper R. (eds) *The Handbook of Technology Foresight: Concepts and Practice*, Elgar: Cheltenham, 2007

[3] Mu R, Ren Z, Yuan S and Quiao Y, 'Technology foresight towards 2020 in China': the practice and its impacts, Technology Analysis & Strategic Management Vol. 20, No. 3, May 2008, 287–307

[4] Martin BR and Johnston R, Technology Foresight for Wiring Up the National Innovation System - A Review of Recent Government Exercises, Technological Forecasting and Social Change, Volume 60, Number 1, January 1999 , pp. 37-54(18)

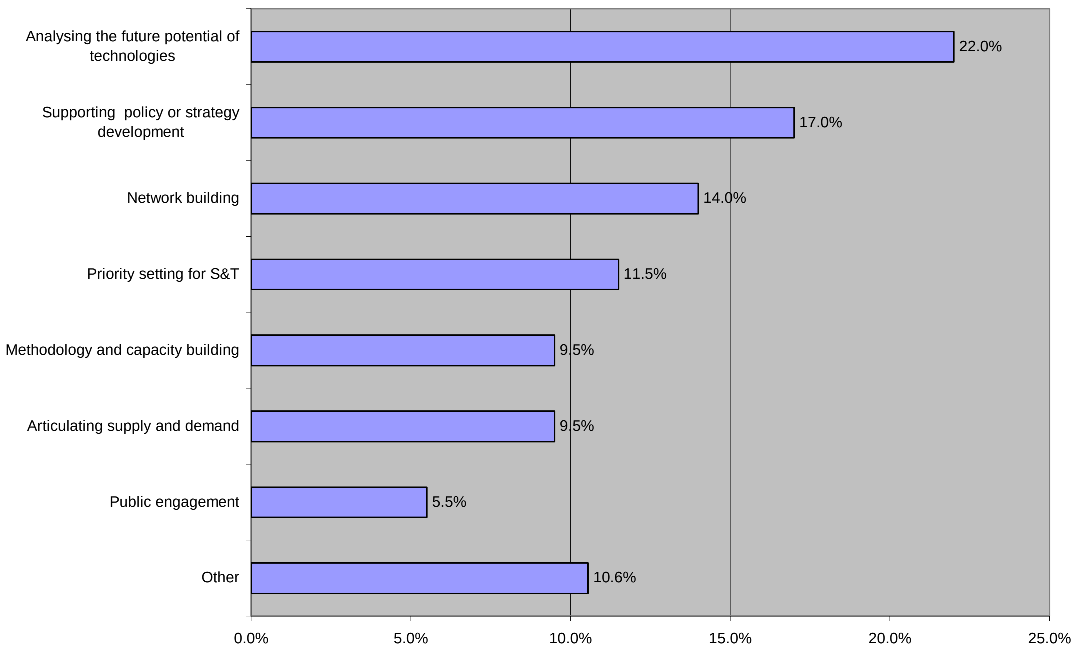
[5] Gavigan J et al, FOREN Guide - Foresight for Regional Development Network - A Practical Guide to Regional Foresight, European Commission, December 2001

appropriate policy mix. A gradual awareness and general agreement for moving away from one-size-fits-all approaches is giving foresight an enhanced role in policy design tailored to particular context, national, regional, local or sectoral.

Recent trends in research and innovation policy have opened new opportunities for the application of FTA. The emergence of coordinating instruments such as technology platforms is normally crystallised around a technology roadmap; the planning and emergence of knowledge-based clusters is often informed by a vision; new demand-side innovation policies such as the use of innovative public procurement and regulation to pull through innovations requires a shared vision on the part of purchasers and suppliers. The role of FTA in such contexts needs both to be enhanced and better understood.

In the corporate world, the rise of open innovation has emphasised the need for firms to work with their collaborators and others to monitor, analyse and shape the future of their innovation environment[6]. Firms are increasingly playing a role in defining innovation policy due to the rise of demand side approaches and the convergence of corporate and structural foresight. In the open innovation systems firms are less concerned with stand-alone type foresight and more about how corporate strategy interfaces with the emerging research and innovation policy scenario. Daheim and Uerz at the previous FTA conference noted the emergence of open foresight as a trend, where the openness extends through wider stakeholder involvement, a broad thematic perspective, an ongoing process, and a sensitivity to disruptive trends.[7] Developments here also need to be tracked and better understood.

**Figure 1 Analysis of Objectives of 50 Foresight Exercises**




[6] Chesbrough H. The era of open innovation Sloan Management Review Vol 44 (3) Spring 2003
[7] Daheim C and Uerz G, Corporate foresight in Europe: from trend based logics to open foresight, Technology Analysis & Strategic Management, Volume 20, Issue 3 May 2008 , pages 321 - 336

Figure 1 summarises the results of an analysis of 50 foresight exercises described in the European Foresight Monitoring Network (EFMN) database[8]. These exercises listed a total of 199 objectives which have been classified here by the authors. The most popular group is one we have called analysing the future potential of technologies. This reflects a type of foresight which preselects one or more areas of science or technology and uses FTA approaches to assess their potential and the actions needed to take them forward. The second group is distinguished by focus on a particular policy domain, economic or otherwise, and use FTA to develop policy (or business strategy). The third group is almost always associated with the verb "to foster" and reflects the aims of many exercises to promote networking between actors in research and innovation. It is noteworthy that the specific remit of prioritisation is present in only 11.5% of the objectives listed, hence a minority of the exercises reviewed. Many exercises have an explicit goal of developing FTA methodologies or the capacity to use those methodologies and this forms the next grouping. With a similar frequency there is a group of objectives which seek to articulate supply and demand fir technology or innovation. These almost always make reference to market opportunities or societal demand. The last distinct category is that of public engagement in FTA. The "Other" category consisted of some objectives which were very general and others which addressed various aspects of R&D strategy or policy. From this analysis we may conclude already that FTA has moved on from the type of objective setthat typified the large national foresight programmes of the 1990s.

In this paper we aim to question the 'traditional' stand-alone type of foresight activity which aims to develop research priorities. Our contention will be that the validity of this type of approach is being challenged first by a recognition that such priorities cannot exist independently of a consideration of the structures and infrastructures that are needed to support that research. This has been manifested in a growing structural focus for foresight. Beyond this if we expand the vision to innovation policy the focus is very much upon using FTA methods to achieve alignment of the principal stakeholders around an agenda for the future. This trend has begun to be mirrored in research policy-making where to a certain extent we can see a polarisation of approaches between, on the one hand, those seeking to engage key stakeholders through short-duration activities such as scenario workshops, and on the other hand ongoing activities such as horizon scanning activity which provides the basis for informing the first type of approach.

In Section 2 we discuss the inherent limitations of priority setting exercises, in Section 3 we catalogue the emergence of structural foresight and in Section 4 its growing role as an instrument for aligning actors in innovation. Section 5 goes on to discuss the implications of these arguments and to speculate on the future role for foresight in research and innovation policy.

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[8] Thanks are due to Rafael Popper who compiled the list of objectives. The EFMN report classified them differently.

## 2. The Problem with Priorities….[9]

If the endpoint of a foresight activity is to be a priority, it is useful first to consider what that term means. At a basic level a priority is simply an activity which is preferred over another. Normally it is encountered in the context of resource allocation, the resources in question being those of finance, time, infrastructure etc. In science and technology policy an OECD report identified three types of priorities[10]:

- Thematic priorities – referring to fields of science and technology;
- Mission-oriented priorities – referring to socio-economic or technological goals; and
- Functional priorities referring to characteristics of the science and innovation system.

In dealing with priorities it is difficult to separate the output from either the process that generates it or from the process by which it is implemented. A first step is clearly generating the list of topics to be prioritised. This may exist in advance (for example the current headings used for funding) or may itself be the result of a process. The process is typically a broader socio-political interaction of supply side technology or science push with demand side pull. In an *unstructured* process the various interest groups press their case and by whatever decision process is agreed a list is arrived at. Often the process of list generation is interactive with the later stage of resource allocation.

In the realm of foresight, the process of list generation is taken over by the foresight process itself. Using some combination of foresight methods ideas are generated and filtered until a list exists that may be subject to prioritisation. In the simplest form, for example the US Critical Technologies Program which ran from 1989 to 1998, the output is a list if technologies chosen by eminent experts participating as a small elite group. Normally the full appellation of *foresight* would be reserved for a process that went beyond this to involve a systematic consideration of socio-economic and technical drivers and a process of participation or consultation with either external experts or extending to broader stakeholders. Later critical technologies exercises in Europe such as the French Key Technologies Programme and the Czech Foresight Exercise introduced these key foresight characteristics[11].

Once the list has been generated, the issue of ranking or resource allocation comes into play. A number of techniques exist, most of which involve some combination of systematic application of criteria with a voting or scoring process (raising of course the issue of who is empowered to vote or assign scores or weightings). Some sophisticated techniques exist for decision making, for example the analytical hierarchy approach[12]. A review of some of these methods concluded that most are rarely used in practical situations of R&D resource allocation[13].

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[9] This section of the paper was initially developed for a presentation Foresight in Priority Setting Towards a European Initiative at a workshop "Shaping the European Dimension of Foresight" 28 February - 1 March 2005, brusselsftp://ftp.cordis.europa.eu/pub/foresight/docs/brainstorming_session1_intro.pdf

[10] OECD, Choosing Priorities in Science and Technology, OECD:Paris 1991

[11] Klusacek K, Technology Foresight in the Czech Republic, PREST Discussion Paper 03-15 November 2003

[12] Saaty TL 1980 The Analytical Hierarchy Process, New York: McGraw Hill

[13] Office of Science and Technology and PREST, May 1993, Returns to Research and Development Spending London HMSO

An influential approach emerging from industrial ex ante project selection methods was developed by the Australian national laboratory CSIRO based upon a matrix of attractiveness and feasibility. These terms represented combinations of the scale of benefits and the ability to capture them (attractiveness) and R&D potential in the area plus the capacity to realise that potential (feasibility). In the planning for the first UK technology foresight programme this system was articulated further to introduce the dimensions of cost and timescale[14]. Criteria were amplified into checklists. This paper also recommended that that the output from the prioritisation process should provide strategic advice about how to change the future rather than just a simple list of priorities for expenditure, and that, given the wide range of risk/reward profiles among the selected areas, that a portfolio approach should be adopted. In the event, as Keenan has documented[15], a simplified, if not simplistic, approach was adopted with the results that the priorities that emerged had a rather limited effect and that the programme moved sharply towards its second, networking, objective, which saw priorities (in the sense of funded areas) emerge as bottom up projects at a much more focussed level.

From this discussion we can identify a number of issues that must be faced if using foresight to identify priorities:

**Generation of initial list:** It should be clear that without a preceding foresight stage this is the product of historical inertia or straightforward political lobbying. In the process of generating the list it is likely that the types of information needed to make decisions will also be collected.

**Level of granularity**: Typical lists that emerge are at a high level of aggregation (ICT, biotechnology, nanotechnology…) or at one level down listing around 100 key technologies. Functional priorities are normally far fewer in number and might typically concern resourcing (finance, human resources and infrastructure) for science, and industry-science linkages. The issue is how actionable such lists are. Keenan identifies a trade-off between the need for sufficient focus as to be meaningful for action and the manageability of the potentially very long lists that might result.

**Separability of priorities**: At one stage in the UK it was proposed that university block funding for research (QR) from the Higher Education Funding Councils should be differentially allocated between fields according to their correspondence with priorities emerging from the foresight programmes. A study to this effect indicated that it was very difficult to map the priorities to the different disciplinary finding categories used, and that in any event, the interdependencies between fields meant that anomalous results could arise. For example Information Technology could be an explicit priority while mathematics was not but the former might be highly dependent upon inputs from the latter. Since, a decade earlier an attempt to construct matrices of such interdependence had collapsed under its own weight the idea was not further pursued.

**Link to implementation channels:** It has been observed by Rip and Nederhof[16] among others that the announcement of priorities does not necessarily lead to a dirigiste allocation of resources. Priorities serve more as an instrument of

[14] SQW/PREST 1994 Prioritisation Criteria, A paper to the UK Technology Foresight Steering Group
[15] Keenan M Identifying Generic Technologies at the National Level: the UK Experience Journal of Forecasting 22, 129-160, 2003
[16] Rip A and Nederhof AJ, Between Dirigism and Laissez-Faire: Effects of Implementing the Science Policy Priority for Biotechnology in the Netherlands, *Research Policy* 15 (1986) 253-268

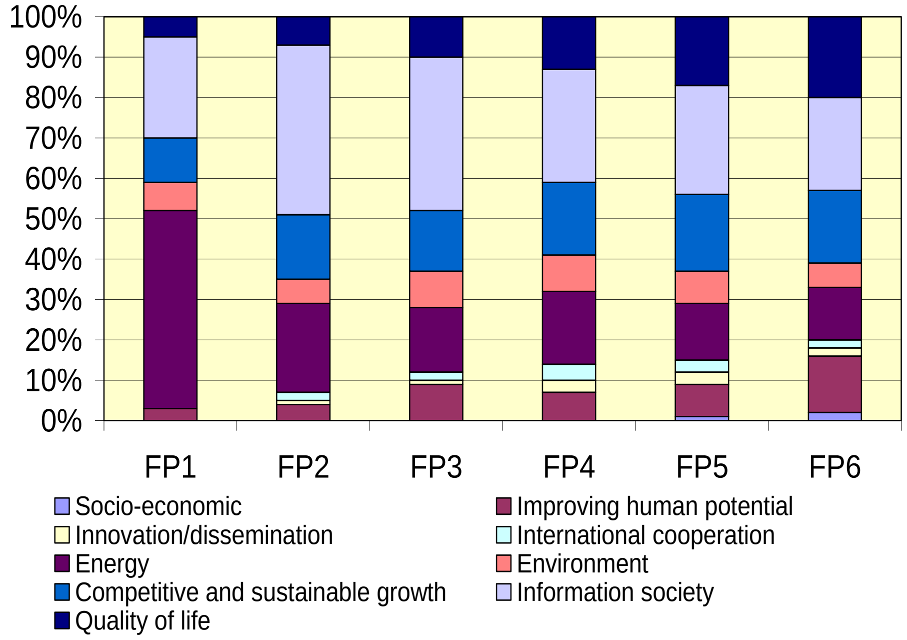
orchestration, whereby policymakers and researchers adapt to each others goals. Put more simply, researchers and funding intermediaries may be influenced by announced priorities but that influence has its limits – for example a new terminology may in part be used to re-label existing activities but use of the new label may then begin to change the self-perceptions and orientations of researchers.

**Limits of Scope of Priorities:** Priorities may be applied to a particular programme budget but their successful implementation may rely on complementary developments elsewhere (for example in the supply of trained people) and it may be that the same priority is not afforded in both situations.

A different limitation of scope is that of the proportion of the influenceable budget that is free to be reallocated. An easy option in political terms is to apply prioritisation only to growth in budgets (if indeed they are growing) and achieve change through the gradual shift that would entail. A tougher but still limited approach, very often used by funding bodies, is to "top-slice" a proportion of resources from competing recipients and then reallocate that to the best bids made against priority themes.

**Priorities and "Posteriorities":** A well-known phenomenon is the extreme reluctance of panels to identify negative priorities or "posteriorities" from which resources may be transferred to positive priorities. The same is true to some extent for programmes and funding bodies – a client body builds up around particular themes and these constituencies then form powerful lobbies for continuing support. Figure 2 shows the evolution of the Framework Programme priorities. At one level this shows a successful transition away from large emphases on energy in FP1 and ICT in FP2. However, if growth in the budget is considered, apparently de-prioritised areas are not necessarily run down in absolute terms, but only in relation to the growth of more favoured alternatives.

**Figure 2 Evolution of Framework Programme Priorities**



**Portfolios not Projects – lessons from industry:** Research on prioritisation practice in the world's leading research companies in the USA and Europe has indicated that corporate labs had moved away from the traditional, discipline-based organization[17]. Rather, research targets are established centrally first, and groups with different expertise are formed around them. These multidisciplinary and cross-business function programs are aimed at technology leaps in strategic areas. Projects are not the focus of detailed selection effort – the primary issue is one of addressing broad technology goals and programme portfolios to meet these targets. Research is organised into a modest number of specific *programmes*. These programmes are in general defined around technologies, (such as adhesives, or semiconductors), or around broad areas of functionality relevant to end-users (eg personal computing). Programmes are **not** couched in terms of particular areas of scientific discipline or expertise, nor are they directly targeted on specific business units in the corporate structure. They also play the principal role in the creation and management of portfolios of research projects. Substantial effort is put into the preparation of technology landscaping or foresight documents as an input to the strategy process[18]. This process could be seen as analogous to the emergence of technology platforms in industry-led public programmes. While this is fertile ground for FTA activity, the actual extent to which it is used systematically to support these processes is probably at a fairly low level.

[17] Coombs R and Georghiou L, A New Industrial Ecology, *Science* Vol 296 p471 April 2002
[18] R. Coombs, R. R. Ford, L. Georghiou, *Generation and Selection of Successful Research Projects*, a research study for the Technology Strategy Forum, http://les.man.ac.uk/PREST/TSF/ (2001).

## 3. Structural foresight

As the analysis of motivations showed, foresight frequently has a structuring role. A distinction may be drawn between structural activities which are intended to build on a thematic or priority-setting approach – for example building action networks around the priorities – and foresight exercises which have as their main aim a structural objective. In the former case, as shown above, the first UK Technology Foresight Programme had evolving objectives which gradually shifted their stress from straightforward priorities to an emphasis upon network building on the industry-academic nexus. New priorities can themselves have structural implications; that same exercise was seen as an instrument to shift resources towards the emerging opportunities for life sciences. In some parts of Eastern Europe priorities are an instrument to move towards a contemporary portfolio and away from the materials science/defence orientation of the Soviet era.

An example of a more explicitly structural foresight is the French *Futuris* exercise. This was industry-led and focused upon reorientation of the national innovation system.[19]

Structurally-oriented foresight most often seems to be invoked at times of change. For Europe, a wave of foresight activity was associated with the accession of new EU Member States from the so-called "transition economies". This we see for the smaller accession states (Cyprus, Estonia and Malta) with the explicit aim of the eForesee project as being "to examine the potential role of foresight in dealing with the structural changes to the economy that accompany the accession process, as well as the integration of accession states into the European Research Area (ERA)."[20] Havas and Keenan have noted a tendency in such countries for science systems to be disconnected from innovation and the broader socio-economic environment and hence for some of their more prominent members to advocate simplistic remedies based on linear model thinking and identifying "isolated priorities" for basic research.[21] Nonetheless, the CEE region has probably been the most focussed upon the "critical technologies" style of foresight with prominent examples including successive Russian exercises[22] and the series of exercises in the Czech Republic[23]. On the other hand Havas and Keenan stress the important role that foresight has had in contributing to the realignment of the science system through bringing it to the fore of discussion and highlighting the missing links which could restore a functional innovation system. More recent exercises both in the countries already mentioned

[19] Barré R, "Foresight in France", in Georghiou L., Cassingena Harper J., Keenan M., Miles I., and Popper R. (eds) *The Handbook of Technology Foresight: Concepts and Practice*, Elgar: Cheltenham, 2007

[20] Crehan P. and Cassingena Harper J. "Foresight in Smaller Countries" in Georghiou L., Cassingena Harper J., Keenan M., Miles I., and Popper R. (eds) *The Handbook of Technology Foresight: Concepts and Practice*, Elgar: Cheltenham, 2007 p.217

[21] Havas A. and Keenan M., Foresight in CEE Countries in Georghiou L., Cassingena Harper J., Keenan M., Miles I., and Popper R. (eds) *The Handbook of Technology Foresight: Concepts and Practice*, Elgar: Cheltenham, 2007 p.290

[22] Sokolov, A. 'Identification of National S&T Priorities Areas with Respect to the Promotion of Innovation and Economic Growth: The Case of Russia', in Bulgarian Integration into European NATO, NATO Security through Science Series: Human and Societal Dynamics, IOS Press, pp. 92–109, 2006: and Sokolov, A.), 'Russian Critical Technologies 2015', European Foresight Monitoring Network Brief, 79, available at http://www.efmn.eu.

[23] Klusacek, K., 'Technology Foresight in the Czech Republic', International Journal of Foresight and Innovation Policy, 1(1–2), pp. 89–105, 2004; Klusacek, K., 'Key Technologies for the Czech National Research Programme', paper presented at the UNIDO Technology Foresight Summit, September, Budapest, 2007

and also in Romania and Poland have had a more explicit objective to shape the research and innovation system. For example the Romanian Science and Technology Foresight 2005 sought to reconstruct the RDI system around long-term perspectives. Typically there is a tension between the expectations of sponsors who remain focussed on deliverables in priority list format, and the participants and operators of foresight exercises who confront the realities of the need for structural change and a process-oriented approach.

Another kind of structural foresight has an actor-focus. For example this was an explicit objective of an EU project which sought to examine the future of “Key Research Actors” in the European Research Area encompassing civil society, researchers, small and medium enterprises, universities, research and technology organisations, multinational enterprises, national and regional governments.[24] A key contention behind this exercise was that “current policies are excessively technology-centric and may miss crucial emerging attributes of research and research actors in the knowledge society”. A number of FTA exercises have addressed actors. Universities have been a particular focus. A review for the last FTA conference noted an increasing use of scenarios for the sector in the face of a number of pressures and trends such as student consumerism and competition from new entrants to the sector.[25] Havas has argued that the actor-based approach is only meaningful if it is embedded in an understanding of the research systems in which they operate, expressed as a series of cascading visions.[26] This implies a convergence with the broader structural exercises discussed above.

The question needs to be raised on how effective structural foresight is in achieving change. In the university sector the scenarios of change have attracted public attention but so far the system remains largely unreformed. One reason for this is that is many national environments there is insufficient autonomy or strategic space for universities to act upon the insights arising from foresight. The reviews cited above also showed that it was rare for individual institutions to have meaningful FTA activities. A similar finding has been reported for the corporate sector where Cuhls and Johnston indicate that foresight may be initiated to provoke organisational change but has its impact limited by internal resistance.[27]

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[24] Akrich, M. and Miller, R., Synthesis paper - The Future of Key Research Actors in the European Research Area, Commission of the European Communities, EU 22961 EN, 2007

[25] Georghiou L and Cassingena Harper J, The Higher Education Sector and its Role in Research: Status and impact of International Future-Oriented Technology Analysis, in Cagnin, C.; Keenan, M.; Johnston, R.; Scapolo, F.; Barré, R. (Eds.), *Future-Oriented Technology Analysis Strategic Intelligence for an Innovative Economy*, Springer, 2008

[26] Havas, A., Devising futures for universities in a multi-level structure: A methodological experiment, *Technological Forecasting and Social Change*, Volume 75, Issue 4, May 2008, Pages 558-582

[27] Cuhls K and Johnston R, Corporate Foresight, in Cagnin, C.; Keenan, M.; Johnston, R.; Scapolo, F.; Barré, R. (Eds.), *Future-Oriented Technology Analysis - Strategic Intelligence for an Innovative Economy*, Springer, 2008

## 4. FTA Aligning Actors in Innovation Policy

Structural issues are also to the fore in an emerging important application of FTA, its use to align actors around innovation objectives. Simpler definitions of innovation present it as "the successful exploitation of new ideas"[28] However, success for business at least is defined very clearly in market terms, so it is not surprising to find that the more direct corporate applications are largely concerned with understanding the drivers of future markets. At one end of the scale there are units which scan macro trends in the economy, society and technology which may impact upon the business and its innovative activities. Rollwagen *et al* describe this process in Deutsche Bank which they summarise as "Foresight explores and assesses business opportunities as well as upcoming strategic, organisational and business environment related issues".[29] Other corporate activities are more directly engaged with the specifics of innovation: Becker reports that a small group of firms (DaimlerChrysler, Philips and Decathlon) use foresight in a catalytic role to stimulate and enhance their innovation processes by improving communication and building linkages between partners or even to generate new product ideas directly. [30]

The use of FTA approaches to build linkages for innovation represents a focus for FTA activity in innovation. It has long been understood that foresight in particular has a role in building shared strategies – see Georghiou in 1996:

> "It could also be postulated that, as firms become increasingly dependent on complementary or external sources of technology, formulation of strategy, previously an internal activity, must at least in part now be carried out in the public arena. By collaborating in their thoughts about the future, organizations may be better placed to anticipate the actions of their customers, suppliers and others, such as regulators, who are likely to influence the environment in which they will operate. This argument is
> particularly strong for innovation in complex public/private systems such as vehicle route information technologies, where coordinated action over a period of years is needed to put the system in place."; [31]

and the succinct expression already mentioned from Martin and Johnston "wiring up the innovation system" through strengthening connections within it.[32] Foresight becomes a systemic innovation policy instrument as defined by Smits and Kuhlmann[33], serving the function of enhancing the capability of innovation systems for self-organisation and raising the level of analysis for innovation policy to the system level. Warnke and Heimeriks
caution that this alone will not lead towards certain socially desirable areas of innovation and that a broader set of actors, including social scientists, need to be

[28] See for example UK Innovation White Paper *Innovation Nation*, Department for Innovation, Universities & Skills, CM7345, March 2008

[29] Rollwagen, I., Hofmann, J. and Schneider, S. Improving the business impact of foresight, *Technology Analysis & Strategic Management* Vol. 20, No. 3, May 2008 p.339

[30] Becker, P., Corporate Foresight in Europe: A First Overview, Commission of the European Communities, EUR 20921, October 2002 p10

[31] Georghiou, L., The UK Technology Foresight Programme, *Futures*. Vol. 28, No. 4, p.361

[32] Op.cit.

[33] Smits R & Kuhlmann S (2004) 'the rise of systemic instruments in innovation policy' Int. J. Foresight and Innovation Policy, Vol. 1 Nos. 1/2 pp. 4-32

brought into the range of engaged stakeholders if the user-producer learning space is to be properly appreciated.[34]

While the rationale for innovation policy remains anchored in the Arrow concepts of market failure for many government economists, in recent years there has been a growing recognition that systemic failures are just as likely to impede successful innovation. This highlights the fact that innovation is not simply a sequential progression from the areas of science and technology that may feature in priorities exercises but rather involves the mastery or areas such as training, design, finance and marketing and their successful integration. This thinking was also the basis of the “open innovation” concept in that it recognises centrally that innovation is a process of interaction between firms and their external environments and that firms do not innovate alone, but by interacting with universities, technological institutes, consulting companies, suppliers and even competitors.

The type of deficiencies that innovation policy seeks to correct include lack of integration also at the level of the policy framework itself, failures of key institutions to form linkages or to undertake coordinated action, and a disconnection between the development and application of new technologies and the societal and business issues which are wanted by the public and their political representatives. At the level of the firm there are problems of short-term and reactive thinking caused by a preoccupation with immediate business problems, technological lock-ins and an inability to engage in the kind of networks now recognised as the environment in which innovations are most likely to emerge. Within the scientific system an inability to configure work around interdisciplinary problems and to manage the interfaces with business and other stakeholders represents a further barrier which may be rooted in institutional structures and limited human resource capabilities among other reasons.

Considering these issues there is a prima facie case for the application of FTA approaches on a substantial scale. Breaking away from restricted and short-term vision and seeding new configurations is at the core of what most FTA approaches are about. How then does this relate to trends in innovation policy?

An emergent opportunity for the application of FTA is in demand-side innovation policy. This represents a reorientation of innovation policy which attempts to match the traditional supply-side measures with new demand-side measures. Supply-side refers here to the provision of firms with resources, technological knowledge and/or the capabilities to innovate. This can be by means of grants, loans, fiscal incentives, consultancy support, and various forms of support for equity and debt guarantees. By contrast demand-side measures seek to use instruments such as public procurement, standards and regulation to pull-through innovations. They also encompassing measures such as clusters and platforms which seek to bring together demand and supply. [35,36]

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[34] Warnke, P. and Heimeriks, G., Technology Foresight as Innovation Policy Instrument – Learning from Science and Technology Studies, in Cagnin, C.; Keenan, M.; Johnston, R.; Scapolo, F.; Barré, R. (Eds.), *Future-Oriented Technology Analysis*

[35] Aho, E., Cornu, J., Georghiou, L. and Subira, A., (2006) Creating an Innovative Europe. Report of the Independent Expert Group on R&D and Innovation appointed following the Hampton Court Summit. January 2006

[36] Georghiou, L. ( 2007) Demanding Innovation – Lead Markets, Public Procurement and Innovation, NESTA Provocation 02: February 2007, London:NESTA

Looking at this last category, the cluster is a case in point. Originating as an explanatory tool from Michael Porter in comparing the competitive success of nations, this approach is understood as concentrations of industries supporting each other. A cluster was originally identified by means of analysis of market interactions between industries along value-chains. However, the approach also emphasises the means by which framework conditions affect complex linkages within and between industries and the influence of social, economic and cultural factors. The cluster approach has also been applied in analysing non-market interactions resulting in, for example, knowledge clusters. An early example of this concept was the Finnish Governments knowledge cluster programme of the mid-1990s. Here the aim was to mobilise actors and networks by reference to the research focus of their activities rather than to the location in which these activities are carried out. Knowledge cluster programmes allow a focus on areas of an economy in which there is potential for innovation and growth and connect actors which are important for innovation. While the direct use of FTA was not documented at the time in that example, it is interesting to note that one of the most successful has now evolved into an ERA-Net "WoodWisdom" dealing with the integration of forestry and wood material science and engineering. This has made use of FTA in the form of internet-based decision support tools. As an example of embedded foresight, Brummer et al indicate three roles for such an application of foresight: i) vision-building for clarifying shared interests and joint benefits of international collaboration, ii) networking for mobilizing the RTD communities in different countries and iii) priority setting for formulating promising research themes and corresponding resource allocations.[37] They see this as indicative of a policy trend away from finance and towards that facilitation and monitoring of stakeholder processes that do not necessarily have a central agent. In this context, embedded foresight activities promote the development of internal collaboration.

More recently prominent demand-side policies include use of regulation and standards to stimulate innovation. The application of FTA approaches to these areas has been explored by Blind who focuses on approaches which identify future fields for regulatory action but also opportunities for regulation to foster the development of new markets.[38] A series of methodological options, including scientometric indicators, surveys and Delphi studies are reviewed in the light of experience. An important finding in relation to the interest of this paper is that a simple transfer of the methodologies to identify emerging science and technology fields into regulatory foresight is not sufficient. Rather, it is argued that significant adjustments and developments are needed to the methodologies, both for the quality of results and to convince the regulatory bodies and other stakeholders of their utility.

When it comes to the use of public procurement as an instrument of innovation policy, the basic premise is that the public buyer can specify requirements that cannot be met from off-the-shelf gods or services and hence that an innovation is required to meet that demand. There is a potential double benefit in that the purchaser receives an innovative solution while the supplier benefits from customer feedback and an assured first purchase.[39] An extension of this concept is the lead market, where there are sufficient buyers of the innovation willing to pay a premium

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[37] Brummer, V., Könnöla, T. and Sahto, A., Foresight within ERA-NETs: Experiences from the preparation of an international research program, *Technological Forecasting and Social Change* Volume 75, Issue 4, May 2008, Pages 483-495

[38] Blind, K., Regulatory foresight: Methodologies and selected applications, *Technological Forecasting & Social Change* 75 (2008) 496–516

[39] Edler, J., and Georghiou, L., Public procurement and innovation—Resurrecting the demand side, Research Policy 36 (2007) 949–963

or take additional risks and other factors such as regulation and competition are favourable. Put simply, a lead market provides a launch platform for innovations which then may evolve to become cheaper and more effective such that they can be rolled out to other markets.[40] There has been a substantial increase in interest in demand-side policy, evidenced for example by the European Commission's Lead Market Initiative.[41]

To understand the relevance of these trends for FTA it is necessary to unpack the factors which underpin successful procurement for innovation. Two conditions need to be satisfied:

i) Procurers at the start of the process are advised to prepare the tender procedure properly and to focus on the various possibilities which the market can provide to satisfy its needs. Known as the market survey or technical dialogue, this stage takes place priori to the procurement process. The use of FTA approaches allows procurers to open up their thinking to technical or other solutions of which they may not have been aware.

ii) In the same way that new solutions may have been out of procurer's horizons, there is also a probability that potential suppliers may not be aware of opportunities for innovation and that procurers may not be aware of the full range of potential suppliers. Use of network building FTA approaches can help to redress this situation.

In sum, as Wilkinson et al put it in a guide to procurement for innovation:

> "The emphasis we have placed upon detecting needs at an early stage and of communicating these to suppliers brings to the fore the idea of using foresight to create a common vision as a framework in which purchaser and supplier can agree on the likely trajectories of innovation. Subsequently, these can be used as a basis for functional specifications that stimulate innovation and require R&D to achieve them."[42]

The common thread in all of these demand side areas is the development of a common vision or technology roadmap to inform procurers of the radical options which might offer innovative forms of supply (and build networks with conventional suppliers); regulators of potential technological and/or socio-economic situations which regulation may promote; and builders of clusters or platforms of the various kinds of linkages which can bind them together in future market and technology development.

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[40] Georghiou, L., February 2007. Demanding Innovation—Lead Markets, Public Procurement and Innovation, NESTA Provocation 02. NESTA, London

[41] European Commission, Communication "A lead market initiative for Europe" - COM(2007)860 (21.12.2007)

[42] Wilkinson, R., Georghiou,L., and Cave, J., Public Procurement for Research and Innovation - Developing procurement practices favourable to R&D and innovation, European Commission, September 2005, EUR 21793 EN

## 5. Future for FTA in Research and Innovation Policy

Rationales for FTA activity have evolved in recent years to feature a range of research and innovation policy concerns reflecting sometimes coinciding but often conflicting transnational, supranational, national and regional contexts. In Europe where efforts have focused on increasing the public and private spend on R&D and Innovation, the extent of policy measures, direct and indirect, has enhanced the expanding reach of R&I policy. This developments have important implications for FTA and particularly for foresight at a time when its utility and potential are being realised both a structuring tool and for the more traditional priority-setting. In this respect, foresight can be regarded as one of a number of policy tools for engineering major changes required in EU research and innovation policy in the coming years. As outlined in this paper, foresight is instrumental in informing the design and implementation of research and innovation policy with three distinctive roles:

- Corrective role – addressing deficiencies and systemic failures and policy lock-ins
- Disruptive role – encouraging an emphasis on crisis or breakthrough events which can completely change the current status quo
- Creative role – stimulating the conditions whereby new networks and structures can evolve and grow.

The traditional emphasis on production of broad-based priorities lists appears to be more of a historical phenomenon than a permanent feature, though the possibility remains that new generations of policymakers will find renewed optimism about what such work can yield if the lessons of the past are forgotten. On the other hand the more embedded role as an instrument of articulating, structuring and delivering research and innovation policy offers a robust future for these approaches. For the community which has developed them the challenge is to ensure that their standards of rigour and creativity are maintained among the much more diverse user base.