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“How to balance quality and societal needs in R&D in a globalized world”

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In his prize-winning book Thomas Friedman argues that recent history will be remembered as the dawn of a new global economy – that the world has become flat. The lesson is that we should think horizontally. Driving forces include the spread of the internet with its worldwide fiber-optic network, the growth of outsourcing and the fall of the Berlin wall. Skeptics have held against this technological determinism, that history is also shaped by politics and culture. They have accused Friedman of not wanting to see the rising inequalities, including inequalities of access to the new technologies. But whatever the arguments, there is no doubt that globalisation – with all the ambiguity of the term – is here to stay. It continues the process of worldwide industrialization and intensifies world-wide interdependencies. In the brief history of the most recent push towards globalisation, ICTs and world-wide networks for the continuous flow of people, ideas, capital and goods ensure that a global knowledge-based economy emerges. Collaboration and competition and how we connect enter a new phase.

Globalisation matters. It has led to a new mood which, depending on one’s outlook and situation, is perceived as an opportunity or a threat. Hardly a public R&D policy speech these days that does not refer to either India or China. Every visitor to these countries returns duly impressed by their unbridled dynamics in the high-tech sector and their investment in R&D. Watching a globalising world taking shape adds to the wide-spread feeling of uncertainty regarding the future. Perhaps a new set of policies will soon have to be added. Historically, we have moved from science policy to technology policy and innovation policies. This time, another layer of complexity that makes existing policies appear in a broader context may be called for: globalisation policies, based on strategy and action.

The theme you have asked me to address is how to balance quality and societal needs. It presupposes that such a balance is possible as well as

desirable. This is a big step forward compared to the kind of debates that were conducted in the 70ies of the last century. Put in a slightly caricaturial vein, these debates pitted something called 'basic or pure science' on the one side against calls for 'social relevance' on the other. The latter was often derided as either being of low scientific quality or ideologically motivated and therefore incompatible with 'real science'. Some proponents of the latter felt they were not accountable to anything or anybody but Truth as revealed to them by Nature. Luckily, this is a caricature that does not do justice to basic research as defined by Stokes in Bohr's quadrant.

The situation has changed by shifting to Pasteur's quadrant in which research into fundamental questions is paired with potential applications. Not that one side has succeeded in persuading the other. Nor – with my apologies to policy-makers – due to the efforts of policy-makers, of research councils, of enlightened university rectors or leaders of the industrial and business community, who succeeded through designing attractive policy schemes and programmes. Rather, the profound current transformation of the research system is the result of the previous success of science and technology, accompanied by complex and interacting processes that range from mass education to ICTs, from deregulation to the end of the Cold War. My colleagues and I have attempted to describe and analyse these changes as the transition of Mode 1 of knowledge production to Mode 2. In the latter, research is performed in the context of application, the production of knowledge becomes distributed over society, occurring in many different and heterogeneous sites, and boundaries between institutions become more porous. Mode 2 knowledge production can also be more volatile, when the practioners who come together for working on a commonly defined problem, will afterwards return to their home base or reconfigure elsewhere in a transdisciplinary way.

This transformation of the research system continues relentlessly. Two structural features stand out. One is that industry has practically abandoned to carry out research in-house, although development work continues. Industry and the service sector have shifted to seeking early and easy access to where new knowledge of interest to them can be found. These are predominantly, but not exclusively, universities. In principle, new knowledge can be located anywhere around the world, although in practice, geographical proximity and informal contacts continue to be important. What makes universities attractive to industry is not so much the knowledge they produce, but their graduates. They know the latest techniques and are

skilled in their use. They have access to the international networks of their professors and form their own. They are considered the nucleus of small spin-off companies and a point of attraction for industry and the service sector to locate near-by.

The second structural feature has occurred in the universities. Having finally been granted more autonomy from the State, they also have to seek multiple funding. The best have embarked on a strategy of internationalization, realizing that links with a likewise globally minded industry are indispensible for a healthy future.

Today, science and technology are perceived by policy-makers everywhere around the world as the motors of economic growth and competitiveness. Support is given to them with the aim of obtaining future contributions to wealth and well-being and, increasingly, in the hope that investment in R&D will also contribute to job creation. The public has taken a vivid interest in science and technology, especially when they feel it impacts their lives. Real or imagined risks have led to protests and refusal. New rules for accountability have become part of the democratic game. The public now "speaks back to science" – and science is well-advised to listen. However, if taken too far, both, the trend towards the privatization of science and the democratization of scientific expertise, may endanger science as a public good. Faith-based movements in the US raise a new spectre of opposing cutting-edge research on grounds of religion and values that do not allow for any compromises without which a democracy cannot function.

If a come-back of basic research can be noticed today, it is not a return of Mode 1 knowledge production with its strict disciplinary boundaries and powerful gatekeepers of disciplines. Rather, the process of societal contextualization of research described above, has affected the core of the research system: the nature and boundaries of disciplines. In the hottest scientific fields the practice of some kind of inter-, multi- or trans-disciplinary interaction has become routine. Physics and biology, mathematics and informatics, linguistics, cognitive sciences and others – all have learned to interact with each other. New research instrumentation, their spread and use across disciplines plays a key role. Institutions also have learned to adapt and to facilitate the emergence of exciting, new research fields.

The re-evaluation of basic, fundamental, curiosity-driven or frontier research

comes partly as a response to an excessive short-termism and a misguided insistence on immediate usefulness. It is based on the realization that 'spaces of innovation' are necessary within the research system, granting greater autonomy to scientific curiosity to explore the unforeseeable.

But there is still another, epistemological-institutional reason. The linear model with its rigid sequence from basic to applied to commercial production, its equally rigid specialization of knowledge and institutional separation, has outlived its usefulness. It simply no longer works. Instead, we can distinguish several sub-processes. They are not different stages. They are interconnected through multiple and unpredictable feed-back loops. Processes of self-organization and recursive iteration are work. The production of new knowledge and of new discoveries is closely interlinked with the process of translating new knowledge into working artefact and into instrumentation that will in turn generate new knowledge, both in the lab and outside. Both of these sub-processes are continuously scanned for their potential of becoming matched to the market, to the demand of users, citizens and consumers and to other manifest or latent societal needs. This is the third sub-process.

In contrast to the linear model where researchers more or less remained assigned to specialized work in one of the phases of the knowledge production chain, the challenge now consists in integrating, coordinating and re-configuring the specialized knowledge and professional skills that abound. With institutional boundaries more open and flexible, researchers are expected to interact not only with each other, but with a wide variety of outsiders, with users, patent offices, ministries or patients groups. Their career paths have changed. Some are setting up their own small firms or find employment in places that were unthinkable to previous generations. Universities have recognized that their most valuable product are the graduates they train. Since they know they cannot be retained there, they make the university's surrounding attractive for themselves and for firms. In turn, this may attract other firms, leading to regional clusters. Thus, a virtuous spiral of growth can be set in motion where all sub-process of an extended knowledge production interact and build upon each other in what may become knowledge-based innovation clusters.

This profound transformation of the research system has led to another kind of leveling than the one discovered by Friedman in his conversation Nandan Nilekani, the CEO of one of the best Indian hi-tech corporations. The

playing field of research is being leveled in the sense that all these research and innovation sub-processes are recognized as being equally important and indispensable when seen from the perspective of societal needs in a globalising world.

However, this does not mean that the world of research has or will become flat. Far from it. It is a dynamic landscape, filled with mountains and valleys. Its mountains offer breath-taking peaks with visions, difficult to climb, but promising unforeseen rewards. The valleys are fertile, but need to be well interconnected. This new research landscape also has urban clusters - densely populated areas to which people flock, where the level of competition is high and where people are willing to pay high rents in order to be part of the crowd. In contrast, one can live more quietly in the rural areas, in which there is less competitive pressure. Rural cooperatives, if properly managed, can also earn a good living and thrive on export.

This new research landscape is inhabited by people, ideas, institutions and new forms of cooperation as well as competition. It thrives and is interconnected through ICT and the ubiquitous use of computers for simulation, modeling and computation. It possesses an unprecedented set of experimental systems, research infrastructures and research instrumentation that spread across, and connect previously separate disciplinary fields. It has open porous boundaries towards the surrounding environment to which it connects through a distributed network of extended knowledge production in which users become co-producers and vice versa.

Yet, this new research landscape needs to be carefully managed, including the self-management of its inhabitants. I speak deliberately of ‘management’, not to sound fashionable or to follow the new managerialism that still has to demonstrate its effectiveness. A social organization form is needed that is neither bureaucratic (a great invention in the 19th century), nor one that rests upon an understanding of academic autonomy that is closed upon itself and refuses accountability. Rather, it is expected to encourage, support and sustain processes of innovation.

Joseph Schumpeter, whose insights into the innovation process have long been dismissed by classical economists, believed that changes in science are of interest only insofar as they transform the outside world, mediated through the market place. Today, we can argue (and Schumpeter would probably agree) that he underestimated the value of ‘radical’ innovations, i.e.

discontinuous advances that have had long-term impact. By often considerably reducing the costs of key economic inputs, they are widely adopted and become the catalysts for major structural change of the economy. Today, more often then not, they are science-based and remain unpredictable. They result from the cultivation of fundamental or frontier research.

The major part of innovations still consists of the recombination of known elements, compounds, procedures and techniques that give rise to continuous improvement. As Keith Pavitt describes it, continuous innovation requires constant improvement in methods of technological search, but technical complexity cannot run too far ahead of scientific understanding. The advances occur through recursive practices of scientists and engineers, involving alternate phases of selection and of corroboration by use.

Schumpeter would probably also agree that, fascinated as he was by the new figure of the 'entrepreneur' as an individual, a better understanding of how institutions and organizations innovate is needed. If it is true that one of the few forms of generic innovation is learning under conditions of uncertainty, how do institutions learn and how do they cope with uncertainty? The process of innovation depends not only on working artefacts, but on matching technological and organizational practices with market and societal needs.

What can be managed if we seek to strike the balance between quality and societal needs? Among the 'peaks' and 'frontiers' we have a prominent newcomer in the European landscape: the ERC. For the first time, it will support 'frontier' research of the highest scientific quality on a genuinely competitive basis. There will be no research agenda nor thematic priorities set from outside, neither from politics nor from industry. Expectations are great that the ERC will show that Europe is able to compete at world level and that through the ERC quality standards will be set throughout Europe, This kind of 'positive contamination' has much to do with raising the quality standards throughout Europe by setting examples.

However, the importance of the relation between frontier and the hinterland is often underestimated. Just as an expedition to the highest peaks depends on thorough preparation and equally excellent support teams, the conditions will have to be created throughout Europe, including industry and the business community, to closely follow, monitor and prepare for what the

best individual teams will bring back from their ventures beyond the known horizons.

Societal needs are partly expressed in the market, and partly go beyond it. This is the reason why successful innovations often provide an answer to an unasked question, i.e. to a latent need or desire that has not yet been expressed. This is where culture enters. Far from being only the guardian of the past and of tradition, culture provides also a window to how the future is imagined. It nourishes, as Arjun Appadurai called it, *the capacity to aspire.* Since the next advances in science and technology, especially in the life sciences, will bring major changes for how we define ourselves and how we will conduct our life, including a restructuration of family and other relationships, we are well advised to listen and to probe not only the scientific imagination but also the public imagination of the future.

Expectations that science and technology will contribute to provide 'solutions' to pressing 'real world problems' remain high. These include health and well-being, a sustainable environment, a functioning technical infrastructure for mobility. But there is also the wish for good governance and for more and better employment. Increasingly, investment in R&D is becoming linked to the expectation that it will lead to more jobs. However, we know that there is *no direct* correspondence between problems in the real world and of science and technology providing adequate and feasible solutions. There is *no automatic* guarantee that more investment will either result in a higher rate of economic growth, more innovation or better employment chances.

And yet, we can be sure that *without* increased investment in RDI and *without* the creation of a solid knowledge base deeply rooted in society, Europe will loose out in the globalising world. We can also be sure that without setting up a space of (relative) autonomy from direct political and economic demands and interference, scientific curiosity in its pursuit of the unpredictable, will be stifled. We can also be sure that if the ERC is not granted the kind of autonomy it needs, the loss of a missed opportunity will be enormous.

Research, and especially research of the highest quality carried out at the frontier of what is known, presents us with a dilemma. On the one hand, we wish that science will pursue the unpredictable that leads to new discoveries and new knowledge. At the same time we wish to control the directions into

which scientific curiosity is moving. We realize that science, like other creative activities, needs an autonomous space. We understand that fundamental research has long lead-times. Like other innovative activities, it carries a high degree of uncertainty. And yet, we are impatient and want to see tangible outcomes. We insist on measurable performance indicators and on deliverables. We want research to be engaged with societal needs and rightly so. Yet we often fail to explain – to ourselves, to politicians and decision-makers, to the public and to the media – that *no such direct links exist.* The research landscape is varied and offers room for different management strategies. It needs to be properly cultivated. Increasingly, science and society, to use these ambiguous terms, are intertwined in a complex process of co-evolution. Societal needs and a favourable climate for supporting innovation and scientific-technical advances are not necessarily simultaneous and yet a process of co-production is at work.

Let me summarize by offering you seven short recommendations.

1. Scientific quality and societal needs are not opposites. They can be balanced, but the processes of co-evolution or co-production that bind them together work in an indirect way and often at different speeds. A knowledge society and knowledge economy has to know this and take it into account.

2. Research is a process that leads into directions that are unpredictable. Innovation is a process that is inherently uncertain in its outcome. This genuine and inherent uncertainty has to be accepted. It is part of the risk-taking that allows us to move beyond known horizons and establish new frontiers. The possibility of failure is part of the game.

3. Scientific, technical and social entrepreneurship is not a generic management skill, but depends on the field, place and circumstances and the right moment in time. Pasteur remarked that ‘chance favours only the prepared mind’. History has proven him right. Preparedness - of individuals and institutions alike - for the unexpected and serendipity in research as for the unforeseen opportunities that innovation holds, is paramount.

4. In seeking a balance, invest in young people. They are the ones who can best translate quality into societal needs and vice versa. They are

the carriers of knowledge and skills that make them attractive to industry and who can create new jobs in the future. They are the representatives of the knowledge society in a globalising world.

5. More multiple-way communication is needed to understand the perspectives of others who are part of the process of building a knowledge society. Scientific and technical outcomes can often be improved by listening to users, patients, citizens, buyers and other partners. Shift the emphasis from research results to explaining how the research process works.

6. The process of 'translating' societal needs for research and the 'translation' of research outcomes for societal uptake should be at the center of such multiple-way communication and beyond. Managing uncertainty, to the extent that this is possible, includes the work of translation. Technological innovation leads nowhere without adequate organisational and social practices. Innovation often rests on the discovery of latent needs.

7. Globalisation means not necessarily that the world is becoming flat, but it means new entrants and a likely change in the rules of the game. Provide early access and be prepared. Keep your own research landscape sufficiently diverse, with a good infrastructure linking the valleys and the peaks, the frontier with the hinterland, the urban clusters with the rural parts.

   I wish you much success!

Further suggested reading:

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