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# Drivers of Change

## The main drivers of change affecting the research and innovation landscape and their implications for EU policy

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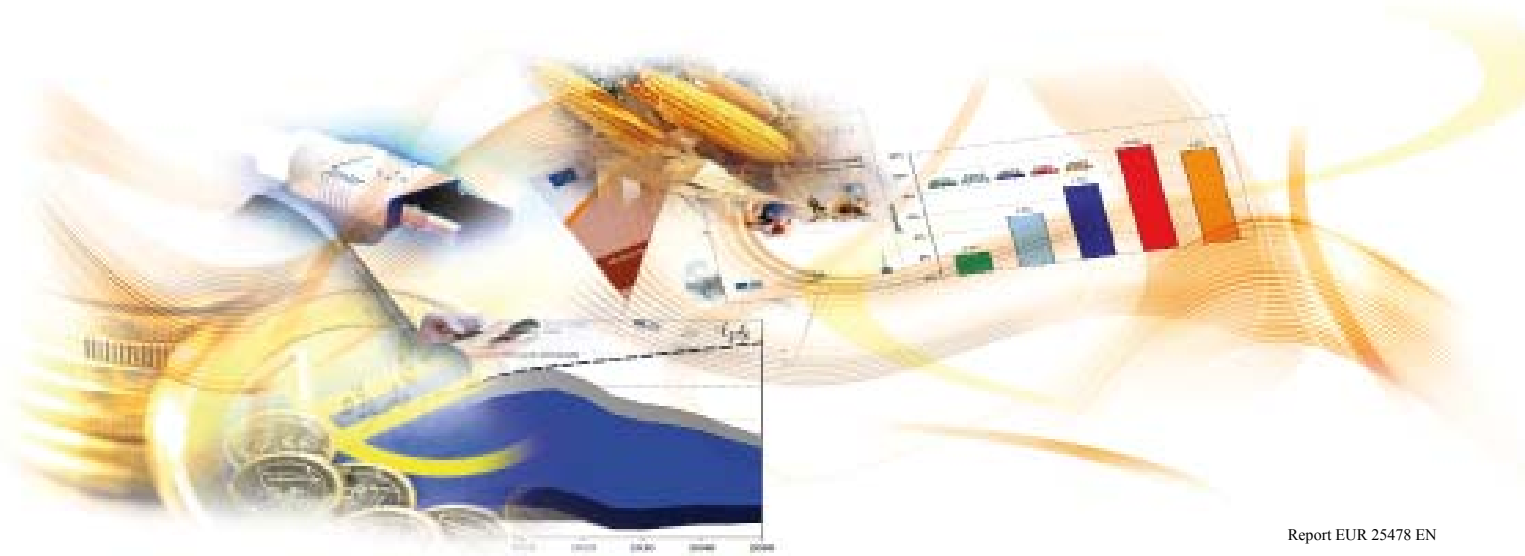

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# Contents

# Summary

*Research and innovation policies are not formulated in a vacuum. They are shaped and influenced by myriad factors both internal and external to the realm of science and technology. In the context of a period of reflection on future support policies in Europe, this policy brief reviews the main drivers of change affecting the research and innovation landscape and their implications for EU policy. It observes that different drivers of change imply the need for similar sets of policy responses and concludes that wholesale changes are needed across a broad front, with a particular focus on eight distinct policy thrusts geared, inter alia, towards strengthening key elements of research and innovation systems, confronting major societal challenges, improving governance systems and enhancing international cooperation.*


# Introduction

Many factors and forces influence the ways in which research and innovation activities are performed and the ends to which they are directed. Dramatic events in natural ecosystems, for example, can stimulate the mobilisation of scientific and technological resources to understand, resolve and mitigate many of the problems associated with developments such as climate change. Similarly, instabilities in political ecosystems can act to reorient the research and innovation priorities of affected governments, and the myriad ways in which industrial structures can evolve across the globe can, in turn, lead to dramatic shifts in the spatial distribution and concentration of research and innovation actors and activities.

In February 2011, the EU launched a public debate on the key issues that should be taken into account when formulating future EU research and innovation funding programmes.[1] The time is ripe, therefore, for a review of some of the main drivers of change affecting the research and innovation landscape and their implications for EU policy.[2] The next section thus considers a series of 'exogenous' drivers, i.e. developments in the broader social, economic and political environments in which research and innovation activities are located that can have profound effects upon these activities. Individual drivers are considered in turn, briefly noting their defining characteristics and outlining their specific consequences for policy.

The following section considers a series of 'endogenous' drivers, e.g. scientific and technological developments that can change policy priorities, or new forms or ways of conducting research and innovation activities that have particular implications for policy formulation and implementation.

[1] European Commission (2011), 'From Challenges to Opportunities: Towards a Common Strategic Framework for EU Research and Innovation Funding', Green Paper, COM(2011) 48, Brussels, 9.2.2011

[2] Since the purpose of this policy brief is to provide a 'tour d'horizon', the coverage of each driver is necessarily cursory. Neither should the amount of space devoted to particular drivers be taken as an indication of relative importance, since less coverage is given to topics that have been discussed extensively in policy fora and more to those that have not.

‘Performance’ drivers are considered in the next section. These are drivers of change that result from reflections on the performance of research and innovation systems and the policies in place to support them. In particular, assessments of performance weaknesses and policy deficits can stimulate new policy initiatives to rectify these deficiencies.

Noting in particular that many drivers – endogenous, exogenous and performance-related – can give rise to similar or common policy responses, a concluding section summarises the combined implications of all drivers for the overall formulation and implementation of EU research and innovation policy.

# Exogenous Drivers of Change

Developments in the broader social, economic and political environments in which research and innovation activities are located can have profound effects upon these activities. Below we deal with some of the policy implications associated with ‘exogenous’ drivers of change spanning:

- The recent and on-going financial crisis;
- Globalisation;
- Regional disparities;
- Demographic shifts;
- Grand challenges; and
- Political instability.

## *Financial Crisis*

The financial crisis that has engulfed the world for the past three years has placed enormous constraints on the availability of the finance needed by both the public and private sectors to invest in research and innovation. Uncertain demand has also constrained investment even when capital has been to hand. The crisis has thus acted as a ‘negative driver’, with particularly harsh repercussions for all but the most affluent of countries and, in the private sector, for SMEs requiring access to external sources of capital. Investment in research and innovation, however, offers a viable recovery route for both public and private sectors, making efforts to ring-fence, maintain and even expand such investment a policy priority, even when there are strong competing claims on scarce financial resources.

## *Globalisation*

The globalisation of trade has led to significant changes in the ways in which enterprises are structured and operate. Even the smallest enterprises operate in global rather than solely local markets, and the largest multinationals – many with turnovers significantly greater than the GDPs of moderately-sized national economies – not only have sales, manufacturing and service units in a broad range of countries, but are also deeply embedded in value chains that span many continents. They are also actively relocating research laboratories and innovation centres across the globe in order to reap the benefits of nearness to market and cheaper sources of highly skilled personnel.

In the ICT sector, for example, MNCs with their headquarters in the EMEA region[3] still had 45% of their R&D centres located in this region in 2007/8, but 13% were located in the Americas region, 18% in the APAC region and 3% in the Japan.[4] In this and other sectors, the overall spatial distribution of research and innovation centres is changing rapidly. On the one hand, there is a tendency for the number of research and innovation 'hotspots' in the world to rise as scientific and technological competences and market potential increase dramatically in countries such as the BRICs.[5] In parallel, however, there is another tendency for the size of some individual 'hotspots' to increase as firms seek the 'cluster' benefits of local agglomerations of research and innovation actors, while other 'ex-hotspots' decrease in size as firms relocate to stronger clusters and foreign locations. One potential outcome for the EU, therefore, is that some hotspots will grow stronger while the overall number of hotspots shrinks.

The implications for EU policy are manifold. Continued increases in market potential and highly qualified personnel in the BRICs and elsewhere are unlikely to lessen and EU policy should aim to help rather than hinder EU headquartered enterprises in their efforts to realise this market potential. At the same time, in order to avoid a net outflow of research and innovative capacity from the EU, considerable efforts will be needed firstly to entice EU headquartered firms to retain some research and innovation capacity in the EU, and secondly to attract non-EU headquartered firms to invest in the EU, particularly in terms of building up their EU-based research and innovation capacity. Policy efforts, therefore, should focus both on the market side – facilitating reciprocal access to open markets across the globe – and on the supply side, via efforts to improve the performance and well-being of the most dynamic local concentrations or clusters of research and innovation actors and activities in the EU, thus making them magnets for footloose foreign investment.

## *Regional Disparities*

In the long-term, the globalisation of trade only makes sense if market potential can be both created and satisfied, which is complicated and confounded by the existence and growth of socio-economic divides and regional disparities that put huge constraints on market development. In the short-term, though, the frequently chaotic, heterogeneous evolution of globalised patterns of trade, production and creative activity can create imbalances and divides that demand policy attention if they are not to become permanent features of the socio-economic landscape. The emergence of strong clusters in some regions at the expense of a corresponding decline in the number and strength of clusters in other regions, for example, is one possibility that could lead, eventually, to a divide between 'innovation-rich' and 'innovation-poor' regions.

[3] EMEA = Europe Russia, the Middle-East to the India border, and Africa; Americas = North, South and Central America and the Caribbean countries; APAC = India, Southeast Asia, China, South Korea, Taiwan, the Philippines, Australia, New Zealand, Indonesia, Indian Ocean and Pacific Ocean countries.

[4] These figures are based on the JRC-IPTS ICT R&D Location Database covering 1,800 sites belong to 80 MNCs considered to be major *semiconductor influencers*. See IPTS (2010), 'The 2010 Report on R&D in ICT in the European Union', JRC Scientific and Technical Report.

[5] BRICs = Brazil, Russia, India and China.

Policy solutions to this dilemma could involve distributive welfare policies, but there is also ample scope for 'smart specialisation' strategies in terms of the development of regional research and innovation capabilities. The logic of cluster development argues for the heterogeneous concentration of activities in a limited number of regions and against the development of homogenous 'look alike' competence profiles in all regions. There is considerable potential, however, for clusters differentiated along thematic or sectoral lines to be distributed across multiple regions in such a way that all regions have distinctive but different competence profiles.

## *Demographic Shifts*

Building up research and innovation capabilities demands a heavy investment in the education and training of highly skilled and qualified personnel, but success depends not only on the quality of educational infrastructures and the calibre of educational service provision, but also on the existence of adequate stocks of human capital. Increasingly over the next forty years, however, the EU is likely to be on the wrong side of a demographic divide that is emerging between different country blocs.[6] In some countries, e.g. India and Brazil, population profiles are becoming increasingly youthful, with the potential size of workforces expected to grow. In contrast, in the EU, as in Japan and, to a lesser extent, the USA, there is an ageing population profile, with the workforce as a proportion of the total population set to shrink. Combined with the fact that interest in science subjects is on the decline amongst EU school students, this means that the stocks of human capital needed to fuel innovation-led growth are likely to be constrained in Europe.

The inescapable onset of an ageing society poses many policy problems, not least of which is how to ensure that sufficient resources are devoted to the production of innovative responses to changing healthcare and social welfare needs. In terms of tackling potential human capital deficiencies, however, there is an urgent need for actions designed to increase interest in science subjects amongst the school population and to promote the concept of 'continual learning' amongst older cohorts. Another imperative will be to step-up efforts to improve the inward mobility of qualified personnel and foreign students, though an even more prescient approach would be to encourage 'brain circulation' strategies with developing countries on the other side of the demographic divide, accompanying these efforts with other forms of assistance designed to strengthen the research and innovation infrastructures of selected partner countries and forge strong, mutually beneficial links with their fledgling research and innovation communities.

## *Grand Challenges*

Coping with an ageing population is just one amongst many of the 'Grand Challenges' confronting the EU, so-called because of the scale or urgency of the disruptive threat they pose to society. The length of any list of such challenges will always be contentious, but there can be no doubt about the inclusion in such lists of topics like climate change, potential energy and natural resource shortages and affordable healthcare – all of which have global as well as EU dimensions.

[6] Archibugi *et al* (2008), 'Opening to the World: International Cooperation in Science and Technology', Report of the ERA Expert Group to DG Research

There is also no doubt that research and innovation have an important part to play in both helping to dimension all of these threats and in combating them. The policy dilemma is how to mobilise sufficient resources in a timely fashion appropriate to the scale and urgency of the threats they pose. This will involve a greater emphasis on 'targeted' research and innovation agendas focused on specific socio-economic problem areas; and it will involve a sea change in the cross-border pooling of national resources dedicated to these ends, since no single country could hope or afford to tackle them alone. Also, because of the global nature of most 'Grand Challenges', levels of coordination and collaboration will necessarily have to extend far beyond the boundaries of the EU. The greatest policy challenge, however, will be to effect all these changes within exceptionally short time-scales – something that will be exceedingly difficult to do without political commitment at the highest levels and a broad consensus concerning the necessity for radical action amongst all relevant stakeholders.

## *Political Instability*

Political instability within individual countries affects economic growth and the investment climate. Much of the literature suggests that radical political change (revolutions, coups, assassinations etc.) has strongly negative impacts on growth.[7] Alesina *et al* (1992; 1995),[8] for example, analysed this relationship in a sample of 113 countries over the period 1950-82. They noted that growth was significantly lower in countries and time periods where there was a high propensity for governments to collapse. Conversely, more recent work by Bellettini *et al* (2009),[9] which studied incremental political changes (e.g. changes of government as a result of democratic elections) in a sample of 56 democratic countries over the period 1975-2004, has demonstrated that there is a negative association between political stability and economic growth in countries with high bureaucratic costs and onerous regulatory burdens. This led the authors to postulate that political contacts with long-term political elites were being exploited by low-quality producers to reduce or evade regulatory burdens, defend monopoly positions and prevent innovation and the entry of high-quality competitors. Efforts to stimulate innovation by reducing such burdens thus have much to recommend them.

Political tensions between countries and terrorist threats also have an obvious impact on political stability and numerous implications for the practice and governance of research and innovation. Heightened tensions, for example, increase the demand for scarce resources to be allocated towards defence and security needs, leading to number of scenarios for the governance of research and innovation. One

[7] See a survey of the literature by Carmignani, F. (2003), 'Political instability, uncertainty and economics', Journal of Economic Surveys, 17, 1-54. Also see World Bank (2011), 'Conflict, Security and Development', World Development Report 2011

[8] Alesina, A., Özler, S., Roubini, N. and Swagel, P. (1992), 'Political instability and economic growth', NBER Working Paper 4173, Cambridge, Massachusetts, USA; Alesina, A., Özler, S., Roubini, N. and Swagel, P. (1995), 'Political Instability and Economic Growth', Journal of Economic Growth, 1, 189-211

[9] Bellettini, G., Ceroni, C. B. and Prarolo, G. (2009), Political persistence, connections and economic growth, CESIFO Working Paper No. 2553, Category 5: Fiscal policy, macroeconomic and growth, February 2009

contemporary study outlines four such scenarios covering developments in the EU (see Exhibit 1).[10]

Essentially the options range from a *status quo* or 'Indifference' option at one extreme, where there is hardly any interaction between civil and defence research, between research and innovation policies, and between national and EU wide policy efforts, to a more fully coordinated 'Integration' scenario at the other end of the spectrum, where there is close cooperation between civil and defence research efforts, demand-led policies that link research and innovation, and extensive alignment of national and EU defence research policies. In between there are 'Competition' and 'Cooperation' scenarios that vary along some but not all of these dimensions.

As political tensions and terrorist threats increase, the indifference option becomes both unlikely and unwise. The need to reap synergies between civil and defence research, the need to link research and innovation effectively, and the need to pool resources in order to gain economies of scale are all likely to increase the pressure on policymakers to adopt more coordinated and coherent policy responses.

**Exhibit 1 – Four Scenarios for Interactions between ERA and Security and Defence Research and Innovation Policy**


*Source: Sandera Project. See www.sandera.net.*

In the longer term, however, the changing nature of security threats may place huge constraints on the ability of governments to evolve coherent policy responses. Wittes (2010)[11] argues that scientific and technological developments in fields such as

[10] The results of the Sandera project (see www.sandera.net) are due to be presented in Brussels at the Final Project Conference on 10 May 2011.

[11] Wittes, B. (2010), 'Innovation's darker future: biosecurity, technologies of mass empowerment, and the constitution', Governance Studies at Brookings, December 08, 2010

biotechnology are increasingly putting enormous destructive power into the hands of individuals and small groups, with significant repercussions for the governance of research and innovation and for the relationship between the state and individuals. "The issue will not simply be managing the threat of biological terrorism or biosecurity more broadly. It will be defining a relationship between the state and individuals with respect to the use and development of such dramatically empowering technologies that permits the state to protect security and at once insists that it does so without becoming repressive".

Heavy-handed attempts to monitor and control scientific developments could stifle creativity and limit benign as well as deleterious impacts, but Wittes argues that attempts to close Pandora's Box are already too late. Instead, "the continued proliferation of these technologies will almost certainly precipitate a significant erosion of the federal government's monopoly over security policy. It will tend to distribute responsibility for security to thousands of private sector and university actors whom the technology empowers every bit as much as it does would-be terrorists and criminals". The policy imperative, therefore, is to anticipate the need for constitutional change and explore the viability of all acceptable options.

# Endogenous Drivers of Change

Scientific and technological developments can change policy priorities and often create the need for new policy interventions. Similarly, new ways of performing research or novel forms of innovation can have particular consequences for policy formulation and implementation. This section discusses some of the policy implications associated with the following 'endogenous' drivers of change:

- New scientific and technological (S&T) opportunities;
- ICT developments; and
- New forms of innovation.

## *New S&T Opportunities*

There are strong aesthetic, cultural and educational reasons for undertaking scientific research, all related to our need to understand the way in which the world works. But there is also strong evidence that research and innovation are linked in complex ways with social and economic benefits,[12] and these potential benefits are becoming increasingly important justifications for the public and private sector funding of research and innovation.

This is not an argument, however, for dedicating all research funding to research specifically geared to the production of social and economic benefits. Certainly there is a need to focus increasing amounts on potential solutions to 'Grand Challenges' (see earlier), but history is also full of examples of 'blue-sky' or 'frontier' research initiatives that have opened up new scientific and technological opportunities with momentous consequences for downstream social and economic impacts, many of which could not have been predicted at the outset. Such research is thus an important trigger for the reorientation of future research activities.

[12] This evidence is summarised in the Commission Staff Working Document that accompanied the EU's Innovation Union Communication – European Commission (2010), 'A Rationale for Action', SEC(2010) 1161 final.

This is why an evolving, dynamic balance exists between funding for 'basic' and 'applied', or 'blue-sky' and 'mission-oriented' research, with the balance shifting towards the 'directed' end of the spectrum as the importance of directing research towards the solution of major societal problems is realised, but with safeguards and ring-fencing in place to ensure that there is always room for 'open-ended' research efforts.

At EU level, national funding for 'open-ended' research has been complemented since 2007 by European Research Council (ERC) funding for investigator-driven 'frontier' research, where scientific excellence is the sole criterion for selection. The rationale for this is predicated upon the assumption that EU-wide competitions based on excellence will eventually improve overall excellence levels in Europe by:

- Allowing excellent researchers to complement national funding that is limited, in some settings, by resource constraints;
- Attracting excellent researchers outside the EU to relocate to the EU;
- Ensuring that excellence is rewarded whatever the location of the research, thus allowing excellence adjudged at EU level to function as a benchmark for the rewarding of excellence in national settings.

Continued support at EU level for the ERC should depend on the attainment of EU added value, namely evidence that excellence levels are truly being raised. This will take time, but already there are promising signs. A forthcoming review of early impacts[13] suggests that scientists of the highest calibre are applying for and winning ERC grants; that papers resulting from ERC projects are being published in prestigious scientific journals; that some of the findings of ERC projects are being hailed as exceptional or landmark advances; and that some researchers outside the EU have been attracted by EU funding. Critically, the results of ERC selection procedures have also been used as the basis for national funding decisions, which could lead in future to a convergence of quality standards.

It is still early days, and definitive proof that EU level competitive funding schemes for 'frontier' research will truly complement national endeavours has not yet been amassed, but all the initial signs suggest that continuation of the ERC policy experiment should be strongly supported.

## *ICT Developments*

Developments in science and technology can and do shape the future practice of research and innovation. The impact of Information and Communication Technologies (ICT) over the last half century on the conduct of scientific research provides ample evidence for this, and contemporary developments in ICT are likely to have as great or even greater impacts in the future on both research and innovation.

Burgelman *et al* (2010)[14] highlight three trends that are likely to have significant – if unpredictable – impacts not only on the practice of research and innovation but also

[13] ERC (2011), 'Early Impacts of Wide-Ranging Impact of the IDEAS Programme (ERC)', forthcoming

[14] Burgelman, J-C., Osimo, D. and Bogdanowicz, M. (2010), 'Science 2.0 (change will happen…)', First Monday, Volume 15, No. 7, 5 July 2010

on the epistemological status of scientific knowledge. The first trend concerns the huge growth in the number of authors that has been facilitated by increasing levels of literacy and the myriad different ways in which ICT allows authors to communicate with disparate audiences (e.g. via the use of blogs and other social networking vehicles). Although a general trend, it is also likely to impact on the world of science, blurring the distinction between amateur and professional researchers and the numbers claiming that their work has scientific status.

The second trend concerns the increasing tendency of scientists to publish results, drafts and progress reports in non-traditional outlets. Informal communications between individual scientists of this nature are certainly not new, but the extent and openness of such interactions are recent developments that have given rise to terms such as 'open science' or 'liquid science'. This has the potential to improve knowledge sharing and collective scientific performance, but it could also undermine the role of conventional scientific publication as the main quality control mechanism in the world of science, with related implications for scientific reward systems and career development.
There are also potential repercussions for innovation given that the attribution and allocation of intellectual property rights (IPR) could become increasingly complex and disputed, with deleterious impacts on the incentive to innovate.

The growth in data availability and processing capacity is the third trend. Not only does this allow increasing numbers of 'amateur' and 'professional' scientists to analyse unprecedented amounts of data using increasingly sophisticated and generally available tools, it could also lead to increased acceptance of the notion that correlation could supersede causation as the bedrock of science, with science advancing "without coherent models, unified theories, or really any mechanistic explanation at all".[15]

The exact form that ICT developments will have on the practice of research and innovation are by no means clear. There is little doubt, however, that they are likely to have dramatic impacts on the way we understand and classify scientific activity; on the filter and control mechanisms that have to be in place to assess and assure scientific quality; on the institutional mechanisms needed to assess and reward scientific performance; and on the shape and form of appropriate IPR regimes. A policy priority, therefore, is to anticipate these impacts and evolve coping strategies.

### *New Forms of Innovation*

Simple models of innovation often involve single manufacturing firms conducting their own research before exploiting the results of this research to produce and market new product, process and service innovations. In reality, however, although this simple model continues to characterise one aspect of the behaviour of some firms, actual practices are much more varied and complex. Interdependencies have long existed, for example, between public sector research organisations and private sector research and innovation actors, and the increasing extent of private-private knowledge-related interactions has highlighted the phenomenon of 'open innovation', whereby companies rely much more than hitherto on globally-traded knowledge

[15] Anderson, C. (2007), 'The end of theory: the data deluge makes the scientific method obsolete', Wired, Volume 16, No. 7

inputs and outputs as well as on self-generated knowledge. Similarly, the growing tendency to involve users in the co-creation of value has led to use of the term 'user-driven' innovation. It also clear that a considerable amount of innovation does not draw directly upon the fruits of research or even on the introduction of new technology. Examples include organisational reforms that alter modes of production, the introduction of new, innovative business models and new models of service provision. The latter example highlights the fact that much innovation occurs in a broad range of service sectors, which nowadays dominate the sectoral profiles of most modern economies. Mention also has to be made of 'social innovation', a term that captures the fact that the public sector has to innovate in order to introduce new and better forms of public service provision.

This complex reality constitutes a driver for new policy responses simply because the majority of conventional innovation policies have tended to be underpinned by the simple model of a single manufacturing firm exploiting the results of its own research. The policy priority, therefore, is to evolve richer sets of policy instruments that are customised to serve the needs of different forms of innovation.
For 'open innovation', for example, the need is to remove barriers to the free flow of knowledge between different actors within IPR regimes that remain fair, equitable and acceptable to all interested parties. In contrast, for innovation in the service sector and 'social innovation', the policy priority is to create support instruments that have, to date, been conspicuous by their absence.

# Performance Drivers of Change

'Performance' drivers are drivers of change that result from reflections on the performance of research and innovation systems and the policies in place to support them. Assessments of performance can reveal structural weaknesses that call for new policies to rectify them, while considered assessments of the strengths and weaknesses of the policies and policy instruments used to support research and innovation can reveal policy deficits that merit attention. Correspondingly, this section deals with:

- Weaknesses in the performance of research and innovation systems; and
- Policy deficits.

## *Performance Weaknesses*

Policy responses are driven not only by exogenous events or changes endogenous to the research and innovation system that present new opportunities, but also by reflective assessments of historical performance and the ability of the system to attain new policy goals.

Even a cursory review of the performance of the EU research and innovation system[16] highlights three main weaknesses that deserve policy responses aimed at rectifying them. The first concerns underinvestment in research and innovation activities by both the public and private sectors. Compared to its main trading

[16] See, for example, the Commission Staff Working Document that accompanied the EU's Innovation Union Communication – European Commission (2010), 'A Rationale for Action', SEC(2010) 1161 final.

partners, for example, both overall R&D intensity levels and business R&D intensity levels are lower in the EU.

The second (and presumably related) issue is the comparative strength and composition of the science base. Expenditure on higher education as a percentage of GDP is much higher in the US than in the EU and the US leads in terms of various aspects of research publication performance. There are also twice as many US universities amongst the top 100 universities in the world, with a far greater concentration of top researchers in a limited number of major universities than is the case in Europe, where the research community tends to be more widely dispersed.

Thirdly, innovation performance also lags behind both the US and Japan, whilst the current lead over countries such as China is diminishing rapidly. Innovation performance is not commensurate with expenditure on research, suggesting that there is scope for the greater exploitation of research results in the EU – at least for innovation dependent on R&D inputs.

The main thrusts of appropriate policy responses are thus clear. As noted earlier in the section on responses to the financial crisis, current investment levels in research and innovation need to be maintained or increased. Secondly, concerted efforts are needed to bolster the science base via policies designed, for example, to improve research infrastructures and the employment conditions of researchers; to promote the modernisation of EU universities; to promote research excellence; and to rationalise and simplify the rules and procedures associated with the competitive funding of research.

A third key policy response is to design and implement instruments aimed at removing all obstacles preventing innovative ideas reaching the market. This will involve improving access to the finance that innovative companies need at both the early stage of the innovation cycle and subsequently during periods of rapid growth. It will also involve efforts designed to stimulate the creation of new markets and the framework conditions that will allow these to flourish. In turn, this will involve a focus on better knowledge protection; improved knowledge flows; improved standards formulation processes; regulatory reforms designed to encourage innovation and reduce administrative burdens; and the introduction and widespread diffusion of innovation-friendly procurement policies.

### *Policy Deficits*

Deficits in the ability of existing research and innovation policies to effect desired changes in system performance can also act as a driver for change. Within the EU, at different levels of governance, i.e. at EU, national and regional levels, there are two distinct policy deficits. The first concerns the balance between different policy instruments; the second concerns the coherence of different policy efforts and their overall governance.

Concerning the balance between instruments, there has been an historical emphasis on supply-side support mechanisms, with very few instruments designed to stimulate demand. This situation has started to change at EU level and within a select number of Member States, but overall the imbalance is still marked. Weak links between research inputs, innovation outputs and market success, however, suggest the need

for ‘market pull’ strategies to complement existing ‘supply push’ strategies. In particular, there is tremendous scope for innovation-friendly procurement strategies to catalyse the growth of new markets.

Concerning coherence and governance deficits, these manifest themselves at a number of different levels and in a variety of ways. In many contexts – EU, national and regional – there is ample evidence of ‘silo’ thinking in terms of both the formulation and implementation of policies, with correspondingly little evidence of ‘joined-up’ thinking linking policies concerned with the development of human resources, nurturing the science base, supporting innovation and stimulating market demand. There is also a problem of coherence between the policy efforts of individual Member States and between Member States and policy initiatives launched at the level of the EU. Quite naturally, the policies of individual Member States are explicitly designed to meet national needs, but in many instances these needs are shared by a number of countries and coherent, coordinated efforts that reduced fragmentation would be in the collective good.
Expanding the horizon even further, the global nature of many of the challenges confronting individual countries calls for greater efforts to coordinate joint research and innovation-related activities between EU and non-EU members.

At all levels, the problem of silo thinking calls for improved governance structures involving better communication and coordination channels between the various arms of government involved in or touched by research and innovation policy. There is also scope for a new approach to the governance of EU and Member State relationships. Progress in stimulating joint activities and greater coherence between Member State and EU policy initiatives has been made within the context of the ‘Open Method of Coordination’, a ‘soft governance’ approach that has involved the European Commission playing the role of catalyst and facilitator. Progress could be accelerated, however, by the adoption of a stronger form of governance involving the establishment of an agreed regulatory framework covering the introduction of measures designed not only to stimulate new joint activities, but also to remove many of the obstacles that currently limit the extent of cross-border cooperation.

# Policy Conclusions

## *Policy Drivers and Policy Thrusts*

This review of policy drivers and their implications for policy identifies a number of cases where different drivers – exogenous, endogenous and performance-related – imply common or similar policy responses, which in turn suggests that well-designed policy mixes focused on key policy thrusts can be used to counter multiple threats. **Exhibit 2** indicates in a schematic fashion the relevance of individual drivers to the main policy thrusts suggested by the analysis, all of which are summarised below.

***Strengthening the science base***

Not all innovation springs directly from research, but a considerable amount does and continual efforts are required to renew the knowledge base upon which intellectual and economic growth depends. Strong drivers include the need to ring-fence research from the effects of the financial crisis; the need to improve the performance of the science base and make the EU a magnet for skilled resources and foreign

investment in research and innovation; and the ever present need to maintain an environment that can generate radical new ideas and opportunities.

***Improving innovation performance***

Policies designed to improve competitiveness via corresponding improvements in innovation performance are needed as a direct response to the exogenous driver of globalisation and the urgent need to rectify overall performance weaknesses in the EU research and innovation system. 'Smart' policy mixes and governance structures that ensure good linkages between policies affecting the science base and market development are also needed, as are support mechanisms for 'new' forms of innovation.

***Spreading the benefits***

The forces of globalisation and the benefits that can be reaped from local agglomerations or clusters of research and innovation actors place new demands on cohesion policy within the EU. The absence of policies could lead to marked imbalances between 'innovation-rich' and 'innovation-poor' regions, but inappropriate policies could lead all regions to attempt to develop similar types of cluster. The alternative is 'smart specialisation' policies, though the development of these will involve enhanced levels of coordination across the EU.

***Expanding policy coverage***

Increased recognition of the importance of 'non-technological' and other forms of innovation, e.g. 'social innovation', dictates the need to expand existing concepts of policy coverage. The dominant position occupied by service sectors and the contribution they make to economic well-being also makes a focus on policies designed to stimulate innovation within them particularly important, particularly policies promoting the use of ICT to generate new forms of service delivery and innovative business models.

***Focusing on Grand Challenges***

'Grand Challenges' demand urgent policy responses that focus and mobilise resources to combat the threats they pose. Rather than diverting resources away from the policy thrusts needed to respond to other policy drivers, however, every attempt should be made to evolve policies that 'kill two birds with one stone'. Given the market potential of many of the innovations needed to deal effectively with 'Grand Challenges', efforts to improve overall competitiveness and rectify performance and governance weaknesses should prioritise these areas.

***Pooling resources***

Current levels of fragmentation and duplication of policy effort are strong drivers for the pooling of resources. So too is the need for collective responses to 'Grand Challenges', though many obstacles to cross-border collaboration need to be removed before resources in the EU can be effectively mustered to remedy overall performance weaknesses.

## Exhibit 2 The Relevance of Policy Drivers to Policy Thrusts

| Policy Thrusts | Policy Drivers | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Exogenous Drivers | | | | | | Endogenous Drivers | | | Performance Drivers | |
| | Financial Crisis | Globalisation | Regional Disparities | Demographic Shifts | Grand Challenges | Political Instability | New S&T Opportunities | ICT Developments | New Forms of Innovation | Performance Weaknesses | Policy Deficits |
| Strengthening the science base | ● | ● | ○ | ● | ◉ | ◉ | ● | ◉ | ○ | ● | ○ |
| Improving innovation performance | ● | ● | ◉ | ○ | ● | ◉ | ○ | ◉ | ● | ● | ● |
| Spreading the benefits | ● | ● | ● | ○ | ○ | ○ | ○ | ○ | ○ | ◉ | ● |
| Expanding policy coverage | ◉ | ○ | ○ | ○ | ○ | ○ | ○ | ● | ● | ◉ | ● |
| Focusing on Grand Challenges | ● | ● | ○ | ◉ | ● | ● | ○ | ○ | ○ | ● | ● |
| Pooling resources | ◉ | ○ | ○ | ○ | ● | ◉ | ○ | ○ | ○ | ● | ● |
| International cooperation | ◉ | ● | ○ | ● | ● | ● | ◉ | ◉ | ○ | ◉ | ● |
| Improved policy mixes and governance | ○ | ○ | ◉ | ○ | ● | ● | ◉ | ● | ◉ | ◉ | ● |

Increasing relevance of policy drivers to policy thrusts ➔ ○ ◉ ●

***International cooperation***
Globalisation and demographic shifts both call for enhanced levels of international cooperation that seek to improve market access and improve knowledge flows, while confronting 'Grand Challenges' successfully will necessarily involve partnerships across the globe and the evolution of new governance structures for such alliances.

***Improved policy mixes and governance***
Driven primarily by existing weaknesses in modes of governance and the formulation of effective policy portfolios, there is an obvious need for the EU to both improve its own practices and to catalyse and facilitate similar improvements at Member State and even regional levels. The need to constitute effective responses to the 'Grand Challenges' will also necessitate the evolution of new forms of governance.

## *Policy Imperatives*

Considering all the drivers of change and the range of policy thrusts they suggest, it is obvious that **concurrent actions need to be taken across a broad front**. Implementing just one or two policy thrusts will be insufficient, since this would constitute an inadequate response to at least some of the drivers.

However, with so many disparate drivers and related policy thrusts, it will be essential to find 'smart' ways of combining multiple policy thrusts in coherent policy packages that respond effectively to multiple drivers. **The aim should be to find 'win-win' solutions**, whereby policy responses to some drivers also constitute effective responses to others. The potential of markets associated with many of the innovations that will be needed in the 'Grand Challenge' areas, for example, suggests that focusing efforts to improve innovation performance and competitiveness (as responses to the 'Globalisation' and 'Performance Weakness' drivers) in these areas could lead to win-win scenarios.

The scale of the threats posed by many of the drivers and the short time-scales available to mount adequate responses to them also highlight **the urgency associated with the situation**. Political commitment at the highest possible levels will be needed to ensure that key stakeholders across the EU can mobilise resources quickly and effectively.

Efforts at EU level to stimulate international science and technology cooperation have a long history, though these have been peripheral to mainstream efforts to consolidate and strengthen research and innovation more directly within the EU. The relevance of enhanced international cooperation as part of the response to many of the drivers of change, however, calls for **international cooperation to occupy a more central position on the research and innovation policy stage in the EU**.

To summarise, key policy imperatives are:

- **To act concurrently on many fronts;**
- **To turn the threats presented by Grand Challenges into opportunities for sustainable growth;**
- **To appreciate the urgency of the situation and commit to the speedy mobilisation of resources;**
- **To shift international cooperation to the centre stage of EU research and innovation policy.**

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Abstract

Research and innovation policies are not formulated in a vacuum. They are shaped and influenced by myriad factors both internal and external to the realm of science and technology. In the context of a period of reflection on future support policies in Europe, this policy brief reviews the main drivers of change affecting the research and innovation landscape and their implications for EU policy. It observes that different drivers of change imply the need for similar sets of policy responses and concludes that wholesale changes are needed across a broad front, with a particular focus on eight distinct policy thrusts geared, inter alia, towards strengthening key elements of research and innovation systems, confronting major societal challenges, improving governance systems and enhancing international cooperation

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