

# **Insights from Policy Research for the Formulation and Evaluation of Policy**

**A Review of Projects Funded under the TSER Programme and the  
Implications for European Science, Technology and Innovation Policy  
and the Five-Year Assessment of the Framework Programmes**

**Final Report**

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**Ken Guy  
Wise Guys Ltd.**

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# **Insights from Policy Research for the Formulation and Evaluation of Policy**

**A Review of Projects Funded under the TSER Programme and the Implications for European Science, Technology and Innovation Policy and the Five-Year Assessment of the Framework Programmes**

## **Executive summary**

This report aims at bringing together pertinent findings and policy implications from the research projects sponsored by the Targeted Socio -Economic Research (TSER) programme of the European Community in the area of Evaluation of Science and Technology Policy Options, with a view to providing useful material to the 5 year assessment of the Framework Programme currently under way.

In summary the key findings and policy implications can be found in table 1 below, structured in the following areas:

- Innovation System Concepts, Performance and Policy
- Regional Innovation Systems
- Public Research Systems
- Innovation Systems and Enlargement
- Innovation Systems, Globalisation and ICTs
- Innovation Systems and European Welfare
- Strategic Intelligence

**Table 1: Main Findings and Policy Implications of the TSER  
Projects in Evaluation of Science and Technology Policy  
Options**

<b>Innovation System Concepts, Performance and Policy</b>	
<b>Main Findings</b>	<b>Policy Implications</b>
<ul style="list-style-type: none"> <li>• The key feature of an innovation systems approach is its emphasis on the interaction between the actors and institutions within a system</li> <li>• The institutional frameworks set up to promote one set of goals, e.g. competition, can be antithetical to the attainment of innovation-related goals</li> <li>• Innovation policies are often servants of other policies and innovation is affected both by targeted policies and policies which affect framework conditions</li> <li>• Policies aimed at improving framework conditions have an appreciable impact on innovation and economic performance</li> <li>• The development paths of innovation systems are context specific and path dependent</li> <li>• Innovation policy formulation and implementation vary from one national setting to another within the EU, with much less attention paid to regional or EU-level issues</li> <li>• EU industry has become locked into technological trajectories that prioritise labour-saving process innovation in ‘classical’ industries over growth creating product innovation in high R&amp;D intensive sectors</li> <li>• The preference for credit-based financing in Europe over equity-based financing favours process innovation rather than product innovation and new firm formation</li> </ul>	<ul style="list-style-type: none"> <li>• The centrality of interaction within an innovation system implies that innovation policy has to emphasise the importance of interactive learning</li> <li>• Development policies for whole innovation systems have to comprise a mix of policies tackling specific interactions via organisational and institutional change</li> <li>• Competition and technology procurement policy should strike a balance between promoting competition and encouraging the close user-supplier relationships needed for innovation</li> <li>• Policies tackling framework conditions are an important component of effective policy mixes</li> <li>• Innovation policies, like innovation systems themselves, are context specific and path dependent, and have to be based on empirical analyses, intelligent comparisons, experimentation and evaluation</li> <li>• Although it is fitting for national policies to differ across the EU, greater efforts are needed to tackle EU-level issues and customise policies to regional needs</li> <li>• Policies supporting structural change in the direction of more R&amp;D-intensive and less process innovation oriented sectors are needed in the EU</li> <li>• Improved access to capital is needed in order to stimulate new high-tech SMEs and product innovation</li> </ul>
<b>Regional Innovation Systems</b>	
<b>Main Findings</b>	<b>Policy Implications</b>
<ul style="list-style-type: none"> <li>• As with national innovation systems, networking and interactive learning are vital components of healthy systems</li> <li>• Most regional innovation policies are concerned with the simple allocation of resources and focus on innovation within individual firms</li> <li>• Key drivers of innovation at a firm level in the EU are attempts to lower costs, enhance quality and improve skills</li> </ul>	<ul style="list-style-type: none"> <li>• Network-oriented innovation policies designed to improve collective learning processes are essential, especially those that remove barriers to innovation, promote networking and nurture regional institutions</li> <li>• More policies are needed which focus on regional interactions and concentrate on improving the ways firms do things</li> <li>• Innovation policies should help firms achieve not just technology-related goals but also broader goals related to cost reduction, skill enhancement and quality</li> </ul>

<ul style="list-style-type: none"> <li>• Key barriers to innovation are scarcity of funding, the cost of researchers, lack of management time and low workforce skills and know-how</li> <li>• Local universities play an important though often under-developed role in innovation networks, especially in terms of links with large firms and as a source of spin-offs and personnel for high-tech SMEs</li> <li>• Industrial Liaison Offices are often marginal, under-funded units that do not play an effective role in stimulating linkages between universities and industry</li> <li>• Strong regional governance is a necessary (though insufficient) condition for strong regional innovation systems</li> <li>• The independence of regional innovation systems in trade or knowledge competence terms is untenable</li> <li>• The formulation of regional innovation policies requires a broad appreciation of the needs of stakeholders and the feasibility of different development paths</li> </ul>	<p>improvement</p> <ul style="list-style-type: none"> <li>• Policies aimed at improving local innovation networks should include a focus on large firm-university links, complemented by efforts to enhance the interaction of SMEs with local innovation infrastructures, including universities</li> <li>• Efforts are needed to increase the visibility and effectiveness of Industrial Liaison Offices</li> <li>• Efforts to promote the centrality of innovation to regional development are needed even when local governance structures are strong</li> <li>• Efforts to promote regional innovation systems have to focus on links with external systems as well as internal linkages</li> <li>• Support is needed for local efforts to determine regional needs, capabilities and innovation strategies</li> </ul>
<b>Public Research Systems</b>	
Main Findings	Policy Implications
<ul style="list-style-type: none"> <li>• Funding for public research bases has tended to level off over the past decade in many countries, even though developments in areas such as ICTs, biotechnology and new materials have increased the demand for funding</li> <li>• Competition for scarce resources has led many research organisations to adopt new roles and attempt to improve management practices</li> <li>• A preoccupation with industrial relevance has the potential to divert resources away from both basic research and work of a broader social relevance</li> </ul>	<ul style="list-style-type: none"> <li>• Competition for scarce resources means that excellence as a research selection criteria has to be complemented by other criteria emphasising industrial and/or socio-economic relevance</li> <li>• Policy initiatives are needed to help individual research organisations to adjust to the demands of the new research environment</li> <li>• Difficult choices lie ahead concerning the balance between basic research, industrial research and research with broader social relevance unless research funding can be expanded</li> </ul>
<b>Innovation Systems and Enlargement</b>	
Main Findings	Policy Implications
<ul style="list-style-type: none"> <li>• Science and technology infrastructures were neglected during the dramatic restructuring which took place in Eastern European countries in the first phase of the post-socialist era</li> <li>• Subsequently, science and technology systems within individual countries are being reintegrated into the industrial and economic mainstream at different rates (fast, moderate and slow)</li> </ul>	<ul style="list-style-type: none"> <li>• The different rates at which science and technology infrastructures are being reintegrated into revamped economic frameworks call for different policy mixes</li> <li>• EU support for ‘slow’ countries should focus on exchange of experiences concerning the organisation of S&amp;T activities and the formulation of policies, whereas policies for the ‘fast’ countries should focus on more intensive co-operation at all levels of S&amp;T governance</li> </ul>
<b>Innovation Systems, Globalisation and ICTs</b>	
Main Findings	Policy Implications of countries
<ul style="list-style-type: none"> <li>• The diffusion of ICTs and increased access to information has been one of the main drivers of the</li> </ul>	<ul style="list-style-type: none"> <li>• Policy initiatives facilitating the production and diffusion of ICTs and other key technologies are</li> </ul>

<p>regulatory changes and liberalisation underpinning globalisation</p> <ul style="list-style-type: none"> <li>• In Europe, existing patterns of industrial specialisation and comparatively weak responses to the opportunities presented by ICTs have combined to retard the evolution of knowledge-based societies</li> </ul>	<p>urgently needed</p> <ul style="list-style-type: none"> <li>• These include support for research and the early adoption of regulatory changes facilitating diffusion</li> <li>• The threat of an increasing gap between information-rich and information-poor regions should stimulate policies encouraging new patterns of differentiated but inter-linked regional specialisations</li> </ul>
<b>Innovation Systems and European Welfare</b>	
<b>Main Findings</b>	<b>Policy Implications</b>
<ul style="list-style-type: none"> <li>• The process of European Integration contributed to the development of a European ‘social system of innovation and production’ which is characterised by its emphasis on employment protection and social welfare</li> <li>• In contrast, the US system is more market-driven and has more unequal income distributions</li> <li>• Until the mid-1990s, both systems appeared to be evolving towards knowledge-based societies at a similar pace, though subsequent differences in the growth rates of R&amp;D intensity and labour productivity have seen the US draw ahead of the EU</li> </ul>	<ul style="list-style-type: none"> <li>• If the EU is to keep on track vis-à-vis the development of a knowledge-based society, it will be important to raise R&amp;D intensity, rectify the structural dependence on ‘classical’ industries, promote the diffusion of ICTs and generally nurture the development of a healthy EU innovation system</li> <li>• Efforts to keep pace with the USA may mean abandoning the European ‘social welfare’ model</li> <li>• Alternatively, a conscious policy decision to maintain an emphasis on social welfare should attempt to build on features such as the increased demand for quality goods which income equality can stimulate</li> </ul>
<b>Strategic Intelligence</b>	
<b>Main Findings</b>	<b>Policy Implications</b>
<ul style="list-style-type: none"> <li>• Innovation policies need to be based on a keen understanding of the structure, operation and dynamics of innovation systems</li> <li>• Evaluation, technology assessment and technology foresight exercises are indispensable tools in this arena</li> <li>• Localised exercises of this nature have great value in other settings if interpreted with care and sensitivity</li> </ul>	<ul style="list-style-type: none"> <li>• Developing an understanding of innovation systems demands considerable investment in the collection, transmission and assimilation of ‘strategic intelligence’</li> <li>• Via benchmarking initiatives and the use of the Open Method of Coordination, the European Commission has a catalytic role to play in the ‘soft co-ordination’ of intelligence generation and sharing activities</li> </ul>

### **Implications for the 5 year assessment of the Framework Programme**

The logic of the innovation system approach developed and advocated by the TSER research community and other innovation policy researchers and analysts should be an important consideration when the Five-Year Assessment Panel contemplates the contemporary debate within Europe concerning the relative primacy of ‘excellence’ and/or ‘relevance’ as selection criteria for Commission-supported research activities. A key question is whether or not other policy initiatives outside the Framework Programme would be able to provide support for projects deemed to be of great social relevance. If not, a gap could arise in the policy mix needed to sustain a European innovation system geared towards the needs of European society.

The breadth of this policy mix is critical. While it is important that the Framework Programmes (or similar initiatives) continue to bolster R&D capabilities, mechanisms also need to be in place to ensure that there are adequate links or bridges with other activities in other sub-systems. Crucially, this also implies the need for adequate linkages between the policies and policymaking bodies that govern these various spheres.

Whereas links between many of these bodies certainly exist, a question mark hangs over the adequacy of coherent policy formulation for the EU innovation system as a whole.

Current arrangements pertinent to EU innovation activities lie towards the weak end of the spectrum and arguably have to be strengthened considerably if research and innovation-related policies are to have a joined up feel about them.

The ERA initiative has done much to stimulate policy discussions and actions concerning the most appropriate ways of strengthening and improving the EU R&D base. By expanding the ERA concept to include innovation and industrial development as well as research, the debate currently preoccupying many EU policymakers could be fruitfully expanded to discuss appropriate structures for the governance of a European Innovation Area.

The stage would then be set for a radical review not only of how Commission initiatives designed to strengthen the EU innovation system could be orchestrated, but also of the policy needs of the system as a whole and the roles of different actors at multiple levels of governance – EU, national and regional.

The involvement of multiple levels of governance is both necessary and inevitable to avoid the application at an EU level of ‘one size fits all’ policy solutions and to work towards the evolution of structures and solutions that satisfy local needs. This could involve

- calls and selection criteria deliberately designed to satisfy the policy needs of selected countries or regions (e.g. a scheme designed to seed new research and industrial capabilities in the Accession countries via selection criteria which demand the compulsory inclusion of participants from these countries in a proportion of Integrated Projects or Networks of Excellence).
- greater use of Article 169, which encourages and provides EU support for ‘variable geometry’ initiatives involving two or more Member States
- encouragement and support of initiatives geared towards understanding the research and innovation needs of countries and regions.
- establishing of a broader framework for coordination between the different actors involved (e.g. DG RTD, REGIO, ENTR, etc.) and the different levels (European, national, regional, local etc.).

# **1 Introduction**

The aim of this report is to review the results of research projects funded as part of the EU Commission's Targeted Socio-Economic Research (TSER) programme and to infer lessons for the forthcoming Five-Year Assessment of the Framework Programmes, due to take place in 2004. The intention is to tease out the implications of this body of work both for the evaluation of past actions and for the formulation of future policy prescriptions. Before doing so, however, a few words are needed about the policy context in which the Five-Year Assessment will take place and the need for policy learning; about the role of the Framework Programmes in this policy context; about the scope of the TSER programme; about the nature of the Five-Year Assessment exercise; and about the structure of this report.

## **1.1 The Policy Context and the Need for Policy Learning**

The socio-economic landscape of Europe at the start of the twenty-first century is full of challenges. As an economic bloc, the European Union (EU) is not only striving to operate as a cohesive market place in a stable macro-economic environment, but also to grow into a modern, knowledge-based society via a process of sustainable, eco-friendly development. Simultaneously, it is also trying to cope with the demands of enlargement, the problem of how to cope with external threats as diverse as terrorism and global warming, and the difficult task of conceiving and implementing the manifold structural, institutional and political adjustments needed to effect all of these changes.

In terms of confronting most, if not all, of these challenges, the role played by science, technology and innovation is crucial. These activities underpin the health and wealth of modern economies and are the primary facilitators of knowledge-based societies. They are also both part of the problem and an integral part of the solution of many of the environmental – and ethical – dilemmas confronting the EU and the rest of the world. How the activities of science, technology and innovation function and interact with society in general are thus of critical importance.

From a policy perspective, it is vital to enhance our understanding of these activities and interactions if the appropriate policy levers are to be applied and improvements achieved

in the performance not only of scientific and technological activities themselves, but also in the performance of all the socio-economic systems that depend upon them. In particular, this means improving our understanding of the ways in which R&D and innovation are related to downstream impacts on, for example, competitiveness and industrial performance, trade flows and globalisation, economic wealth and employment, and social welfare and cohesion. It means understanding more about the dynamics of R&D-intensive knowledge-based societies and the structural and institutional changes needed to facilitate them. And it means gaining a much better understanding of the interplay between science and technology and the environment; of societal responses to the ethical challenges raised by technologies such as genetic engineering; and of the governance structures needed to administer scientific and technological activities at regional, national and international levels in the broader context of the evolution of participatory democracies.

## **1.2 ERA and the Role of the Framework Programmes**

Many of these issues are now the preoccupation of current policy in the field of science, technology and innovation. At the European Council in Lisbon in March 2000, Europe set itself the target of becoming the most competitive and dynamic knowledge-based economy in the world. Furthermore, as a step towards this end, and as consequence of a growing gap in R&D expenditure levels between the EU and the USA and Japan, Europe also set itself the goal at the European Council meeting in Barcelona in March 2002 of raising R&D expenditure levels from 1.9% of GDP to 3% of GDP by 2010. This is taking place within the context of a determined drive to create a European Research Area (ERA), itself part of the wider unification process in Europe which has manifested itself not only in market terms, but in the creation of other areas such as the European Education Area (EEA) and in the enlargement of the EU itself.

At root, the attempt to constitute (or, more accurately, to reconfigure<sup>1</sup>) the ERA is based on a recognition that scientific and technological resources in the EU are fragmented and sub-critical, and that their effective allocation, distribution and incorporation into an

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<sup>1</sup> One project (TSER 1101) specifically reminds us that research activities and research networks existed prior to the coining of the term 'European Research Area', and that current 'top down' efforts to 'construct' an ERA should build on this 'bottom up' base rather than seek to impose a new structure and mission in a command-and-control fashion.

efficient and effective European system of innovation, i.e. one which is likely to underpin economic well-being and growth, is unlikely without a concerted effort on the part of all Member States to rationalise, restructure and remobilise resources to avoid excessive duplication and focus on collective priorities. Consequently, as a trigger to this process, the Sixth Research and Technological Development (RTD) Framework Programme (FP6) was launched by the European Commission with a structure specifically intended to catalyse and facilitate this type of restructuring. Although the programme still prioritises funding for RTD projects in much the same way as previous Framework Programmes, the new instruments used to do this – Integrated Projects and Networks of Excellence – were designed to encourage the concentration of resources in strategic areas corresponding to Priority Thematic Areas such as ‘Genomics and Biotechnology for Health’, ‘Information Society Technologies’, and ‘Nanotechnologies, Intelligent Materials and New Production Processes’. FP6 also contains specific support for RTD projects concerned with ‘Sustainable Development and Global Change’, and with ‘Citizens and Governance in a European Knowledge -based Society’.

Tellingly, however, significant parts of the overall budget for FP6 are also being allocated to initiatives geared towards strengthening and restructuring the ERA. These include support for activities designed to support the development of human resources, research infrastructures, research -innovation links and science -society interactions. There is also support for strategic intelligence activities such as foresight and evaluation, and for the implementation of the Open Method of Co -ordination – a process designed to involve Member States in the collective definition of policy guidelines with specific timetables for achieving targets; the development of benchmarking and performance indicators to assess progress towards these goals; and the implementation of monitoring, evaluation and peer review procedures to improve this progress.

### **1.3 Socio-Economic Research and the Scope of the TSER Programme**

All these current policy concerns and initiatives have deep socio -political roots. In some instances the decisions to move in these directions may have been influenced by earlier socio-economic research. Hopefully this was the case, since one of the strongest rationales for funding such work is utilitarian in nature. The incorporation of research results into policymaking practice is rarely smooth and straightforward, however. Although some results invariably reach influential parts of the body politic, many others

don't. Sometimes this is due to the lack of relevance of research results to contemporary policy concerns. More probable causes, however, include deficiencies in the dissemination processes involved in transmitting the results of socio-economic research to policy audiences and, at the receiving end, the occasional inability of these audiences to comprehend the significance of such research.

Whatever the causes of this type of failure, a remedy is needed if socio-economic research is to fulfil its utilitarian potential, and it is this sentiment which informed the commissioning and production of this report. During the course of the Third Framework Programme (FP3), the need for socio-economic research relevant to the development of science, technology and innovation policies was recognised and duly supported in the subsequent Fourth Framework Programme (FP4). Within the context of FP4's Targeted Socio-Economic Research (TSER) Programme, 162 socio-economic research projects were funded under three broad headings:

- Science and Technology Policy Options (64 projects);
- Education and Training (36 projects);
- Social Exclusion and Social Integration (62 projects).

Within the first of these categories, the 64 projects relevant to the development of European science, technology and innovation policy were classified by the Commission into the following clusters:<sup>2</sup>

- Systems of innovation (33 projects)
- Technology and society (I) (12 projects)
- Organizational innovation, work, knowledge and the economy (12 projects)
- Technology and innovation policy (7 projects)
- Employment (7 projects)
- Human resources and competence development (2 projects)
- Innovation in education and training via technology (1 project)
- Cities, local areas & exclusion/integration (1 project)
- No cluster (4 projects)

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<sup>2</sup> The total is greater than 64 because 8 projects belonged to two clusters and one project belonged to four. It should also be noted that a small number of projects in the other broad categories also had implications for science and technology policy, particularly the three projects concerned with employment in the 'Social Exclusion and Social Integration' category.

The many topics spanned by these projects illustrate the range of issues deemed relevant at the start of FP4 to contemporaneous policy concerns, and most of the final reports emanating from the projects contained findings and recommendations of potential interest to policymakers. The aim of this review, therefore, is to summarise the main scientific findings of the TSER studies and highlight their policy significance – both to policy development to date and to the formulation of future policies.<sup>3</sup> The fervent hope is that such a review can sharpen the perspectives needed to meet the policy challenges now confronting the EU.

#### **1.4 The Five-Year Assessment Exercise**

In particular, this review is specifically intended to feed into the planned Five-Year Assessment of the European Commission's RTD Framework Programmes. In this exercise, a panel of experts will be appointed in 2004 to review the activities of the previous five years, to explore policy options and to make recommendations concerning future EU science, technology and innovation-related policies. It will focus on all activities carried out under the Fifth Framework Programme (FP5) and those activities initiated during the early phases of FP6.

Undertaking an assessment exercise of this nature demands a formidable understanding of the dynamics of science, technology and innovation systems and a keen appreciation of the relevance and feasibility of particular policy options. A major aim of this review, therefore, is to communicate some of the collective insights and recommendations of the TSER researchers to those responsible for undertaking the Five-Year Assessment.

#### **1.5 The Structure of the Report**

The structure of this report deliberately avoids a comprehensive but ultimately sterile project-by-project review of the findings and policy implications of all the TSER research projects. Instead it takes a more eclectic path, covering about half the projects funded

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<sup>3</sup> Other policy review exercises are currently looking at the policy lessons resulting from socioeconomic research funded under FP5.

and illustrating common themes with examples drawn from an idiosyncratic selection of projects containing some of the more pertinent and persistent lessons for policymaking. The review commences with an overview of what the projects tell us about the theoretical and empirical functioning of innovation systems, especially national innovation systems, and the relationship between the performance of innovation systems and competitiveness and employment – from both macroeconomic and microeconomic perspectives. It comments on the implications for policies and policymaking of the adoption of a systems of innovation approach before focusing in particular on innovation systems at a regional level, stressing the importance of networks, collaboration and university -industry linkages within them. The spotlight also falls on the role of public research systems within innovation systems, the role of science, technology and innovation within the broad context of enlargement, and the role of ICTs in the process of globalisation and the evolution of knowledge-based societies. Additionally, some comments are made about the development of knowledge-based societies within the framework of European welfare regimes before a penultimate section discusses the process of innovation-related policymaking and associated intelligence needs.<sup>4</sup> To conclude, a final section first discusses the main implications of the work of the TSER community for the assessment of past activities with the Framework Programmes before summarising the TSER findings and their policy implications. A few thoughts are then offered on the relevance of an innovation systems approach to future policy debates and decisions.

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<sup>4</sup> TSER research topics not covered in this short review but which still merit the attention of policymakers concern the role of MNCs in innovation systems; the future of the service sector; sustainable development; and a limited number of governance issues.

## 2 Innovation System Concepts, Performance and Policy

Largely due to the endeavours of European authors such as Freeman, Lundvall and Edquist, the concept of innovation systems, particularly national innovation systems, came to the fore during the 1990s. It is not surprising, therefore, that some TSER projects attempted to elaborate the systems of innovation approach and tease out relevant policy implications (e.g. 1004, 1053, 1059, 1077, 1102, 1118). One of these studies (1004) explored both the concept of an innovation system and a number of key issues associated with it. In particular, it focused on the five issues of: interdisciplinarity; technology procurement; innovation financing, corporate governance; and technological entry. The study stressed that the key feature of an innovation systems approach is its emphasis on the interaction between the 'actors' and 'institutions' within a system. This is based on the observation that firms do not normally innovate in isolation but in interaction with other organisational actors (other firms, universities, standard setting organisations etc.) within a framework of existing institutional rules (laws, norms, technical standards etc.). Moreover, the study also pointed out that institutional frameworks set up to promote one set of goals (e.g. rules and regulations designed to promote or ensure perfect competition) can be antithetical to innovation (which relies on interaction and, to a certain extent, collaboration). Public procurement regulations designed to maximise competition, for example, can be inimical to the formation of the close user-supplier relationships needed for innovation to be successful.

Within Europe, the study rightly noted that concern about the innovation deficit of EU economies is justified because the EU economy is weaker than the economies of Japan and the USA in precisely those industrial sectors in which growth, employment creation, R&D, product innovation and dynamism tend to be the greatest. EU industry has become locked into technological trajectories that prioritise process innovation over product innovation, with the consequence that innovation tends to be labour saving rather than job creating and growth as a whole has a lower employment intensity than in Japan and the USA.

In terms of improving innovation performance within the EU, the study highlighted the interaction between high-tech SMEs, large firms and research institutions, noting that this is often critical if successful innovation is to occur (see also 1004, 1010, 1011, 1066 and 1075). It also pointed out, however, that restricted access to capital is an important

constraint on new high-tech firm formation in the EU. Even when capital is available in the EU, the predominant form in which it is available (credit-based financing) often favours incremental process innovation, whereas equity-based financing, which is often used to finance new ventures and new product development, is more common in the USA than it is in the EU. The venture capital market for early-stage developments is also less developed in the EU than it is in the USA.

The centrality of interaction within an innovation system implies that a systems of innovation approach to policy has to emphasise the importance of interactive learning (see also 1061), with the important corollary that appropriate development policies for the system as a whole have to nurture these interactions via a mix of policies focusing on the constituent parts of the system. Moreover, the study also stressed that innovation policy is not an end in itself but a servant of other policies, e.g. policies to attain employment-intensive economic growth or sustainable development.<sup>5</sup> It also made a useful distinction between ‘Targeted’ and ‘Framework’ policies<sup>6</sup>, viz:

#### *Targeted policies*

- Policies that selectively and directly support the development of science and technology;
- Public technology procurement policy.

#### *Framework policies*

- Policies to develop and strengthen the knowledge infrastructure;
- Policies to develop basic institutions which affect interactive learning;
- Policies to create specific organisations to support innovation activities;
- Policies to improve conditions for financing innovation.

Critically, the study additionally noted that the ways innovation systems evolve and develop over time, and hence the appropriateness of many of the policies used to nurture them, are context-specific and path dependent. The notion of an optimally functioning system to which all systems should aspire is thus redundant, and efforts to improve

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<sup>5</sup> Another TSER project (1118) concluded that, in order to be effective, innovation policy must build bridges and blend with broader economic and social policies, which in turn requires a more synthetic approach to policy formulation than has been the case hitherto.

<sup>6</sup> A similar distinction was also made in TSER 1077 between ‘direct’ innovation policies and ‘comprehensive’ policy actions.

systems have to be based on detailed empirical analyses, intelligent comparisons with other systems and ‘learning by doing’ policy cycles based on experimentation and evaluation.<sup>7</sup>

Some of the most important policy implications resulting from the adoption of a systems of innovation approach can be summarised as follows:

- The most immediate implication is that policies should target and promote interactive learning within the context of particular innovation systems;
- Another is that policies should attempt to stimulate both organisational change and changes in institutional rules – specifically those that have both direct and indirect effects on innovation activities;
- Policies aimed at changing institutional rules include demand -oriented instruments, since changes, for example, in laws and regulations can have appreciable impacts on the demand for innovation in the affected areas;
- Technology procurement is a potentially strong demand -side instrument promoting innovation, but many current procurement regulations act to ensure competition and constrain innovation. Policy should strike a balance between promoting competition and encouraging the type of cooperation between users and supply networks that successful innovation demands;<sup>8</sup>
- Policies supporting structural change in the direction of more R&D intensive and less process-innovation oriented sectors are needed in the EU to encourage employment intensive growth. In general, these correspond to those sectors growing most rapidly on a global scale;
- Support for high-tech SMEs and efforts to stimulate their interaction with other innovation actors are critical components of effective policy mixes.<sup>9</sup> In particular,

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<sup>7</sup> TSER 1107 specifically warns against the use of a standard model of an innovation system or network when designing and implementing policies in this field, noting that existing networks differ markedly in terms of structure, organisation, degree of involvement and, crucially, performance.

<sup>8</sup> Technology procurement in the defence sector was the focus of TSER 1079. The study noted that procurement policies in the past had focused on the maintenance of competition between a few key contractors together with strict control over the whole defence procurement process. In contrast, some recent initiatives, e.g. the SMART initiative in the UK, had kept the focus on competition but given more freedom to lead contractors to dictate the composition of their supply networks and research partnerships, thus ensuring that all the innovation -related benefits of networking could be reaped.

<sup>9</sup> TSER 1075 focused on research joint ventures and concluded that support for collaborative R&D was a particularly appropriate vehicle for improving links between universities, public

improved access to capital is needed if the important role of high -tech SMEs in innovation systems is to be fulfilled;

- Generic, context-independent policy prescriptions are very unlikely to improve the performance of innovation systems . Adequate and appropriate policy mixes have to be based on extensive ‘strategic intelligence’ and comparative analyses. The implication for good policy development, therefore, is that adequate resources have to be allocated to the collection, interpretation and dissemination of such intelligence.

The efficacy of different types of policy instrument was a key focus of another TSER network (1020). This focused on the relationships between R&D, innovation and productivity and reviewed the evidence linking various ‘direct’ and ‘indirect’ policy instruments on economic performance. ‘Direct’ instruments corresponded roughly to the ‘targeted’ measures discussed in TSER 1004 (e.g. R&D subsidies and R&D tax incentives), and ‘indirect’ measures corresponded to ‘framework’ measures affecting labour and financial markets. Concerning ‘direct measures’, the network concluded that there was increased support for the view that R&D tax incentives could raise R&D expenditure, but the main conclusion of the network was that ‘indirect’ or ‘framework’ measures had a more appreciable impact on overall innovation and economic performance than ‘direct’ measures. This is not surprising given that the performance of an R&D sub-system within the Russian doll context of broader innovation and economic systems is just one contributory factor to overall economic performance, but it does highlight the inadequacy of policy prescriptions which focus attention solely on R&D sub-systems alone.

The level at which R&D and innovation policies are applied within innovation systems was an issue addressed in TSER 1053, which looked at the co -evolution of science, technology and industrial policies at national, regional and European levels. It charted the development of policy in six EU countries from 1975-97 and pointed to the continuing fragmentation of policy between the different levels of government and the continuing diversity of systems of innovation, with national governments still playing a prime role in policymaking, and European policy still marginal in most science and technology-related areas other than that of regulation. It did note, however, that the

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research institutions and industry, especially in countries lacking significant resources to initiate substantial R&D initiatives, e.g. the so-called ‘cohesion’ countries.

European Commission had done much to stimulate R&D and encourage collaboration and networking, and that it had a catalytic role to play in effecting policy changes at a national level via 'soft co-ordination' approaches rather than via more coercive stratagems. The most important need, however, was for more co-ordination and 'joined up' strategic approaches to policymaking at national and regional levels rather than at a Community level.

### **3 Regional Innovation Systems**

A number of TSER projects examined the operation and development of innovation systems at a regional level (e.g. 1007, 1010, 1011, 1012, 1014, 1058, 1061, 1065, 1108). One of these (1010) compared innovation activities in eleven regions in Europe, four of which had strong, easily identifiable regional innovation systems. In particular, reflecting the general importance of linkages and interactions within innovation systems, it focused on the innovation activities of firms and links with the public innovation infrastructure.

The research found that attempts to lower costs, enhance quality and improve skills were the key drivers of innovation within firms, with innovation conceived broadly to include both technological and organisational innovation. The most important barriers to innovation related to scarcity of funding, the cost of researchers, lack of management time and low workforce skills and know-how. Moreover, all three barriers were more pronounced in less favoured regions.

In terms of linkages, firms within a region rarely considered local universities to be an important source of information about innovation, though they were sought out as partners when problems had to be solved.<sup>10</sup> Typically, large firm links with universities and other actors within the public innovation infrastructure (research institutes, technology transfer organisations, training establishments etc.) were much more pronounced than SME links.

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<sup>10</sup> Another TSER project (1108) did emphasise, however, that there is a much deeper engagement of universities in their regions than is evident in the conventional literature on innovation activities, though this involvement is heterogeneous across regions. This embeddedness stems not only from the research activities of universities and their links with industry, but also from their role in the provision of education, their contribution to the local cultural environment and their involvement in regional governance structures.

Comparing across regions, the study noted that strong regional governance was a necessary but insufficient condition for the existence of a regional innovation system, while strong central governance was correlated with the existence of weak regional innovation systems. The autonomy of industrial organisational units within regions was also strong enough to suggest that firms referring decisions to head offices outside of the region would not hinder initiatives promoting innovation at a regional level.

Perhaps the main policy implication of the study was that attempts to stimulate innovation have to recognise the necessity of measures which help firms, especially SMEs, to achieve not just technology-related goals but broader goals related to overall improvements in cost reduction, skill enhancement and quality improvement. There is also scope for measures that help SMEs take advantage of local innovation infrastructures. These could include SME networks to stimulate better information supply, learning opportunities, collaborative efforts, joint-financing and access to appropriate services. In a similar vein, another TSER project (1037) concluded that there was a particular need for policies aimed at helping SMEs to overcome information difficulties in technological investment project cycles.

A key recommendation of TSER 1010 was that EU support measures aimed at SMEs would benefit from being delivered via regional innovation infrastructures. Support from the Structural Funds should thus emphasise the centrality of innovation support and encourage the transfer of learning opportunities concerning the management of regional innovation policy from strong to less favoured regional innovation systems.

In terms of improving regional innovation policy, the study concluded that there is an urgent need for:

- Policy learning, with regions learning from each other;
- Policy networks, to increase communication and coordination between regional innovation actors;
- Policy bridges, which encourage firms to move into high-tech growth areas;
- Policy consensus, in order to set targets and mobilise resources.

In line with many of the findings in parallel studies (e.g. 1004), the study also emphasised that the formulation of regional innovation policies requires an approach that takes into account the capabilities and needs of all relevant stakeholders and identifies relevant development paths. Resultant policy mixes should then constitute sets of complementary

support measures aimed at rectifying innovation system deficiencies and building on strengths.

The importance of networks, linkages and interactions at a regional level was also the focus of a thematic network (1011), which analysed ten leading regional clusters of high-technology SMEs. It similarly concluded that regional and European-wide RTD linkages and networks are important in the evolution and competitiveness of regional clusters of innovative high-technology SMEs in the EU, noting in particular that large firms and universities play an increasingly important role within regional clusters, often as a source of spin-offs and qualified personnel for high-tech SMEs. In comparison, other technology transfer and knowledge infrastructure elements play a necessary but lesser role in regional development.

Dense inter-firm interactions at regional and global levels are characteristics of successful clusters, with vertical links between customers and suppliers particularly important and successful regional collaboration in research and technological development a pre-condition for successful globalisation.<sup>11</sup> Collective learning processes within the regional, scientific, research and professional labour markets are also important determinants of success for high-tech SME clusters.

Key processes in the development of a regional collective learning capability include spin-offs from large firms and universities (the most important process); formal and informal inter-firm collaboration and networking; and the mobility of key research, scientific, professional and management staff within regional labour markets. All of these processes lead to the diffusion and further development of embodied expertise, innovative technologies, and managerial and research competences between firms, which in turn stimulates new knowledge and shared learning.

The main policy implications drawn by the network were as follows:

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<sup>11</sup> The results of another TSER study (1065) strongly indicated that local geographical clustering does not in itself confer significant proximity advantages in terms of innovation and competition and that autarky at a regional level is untenable, i.e. involvement in national and international networks and markets is a prerequisite for the success of regional clusters.

- Network-oriented innovation policies designed to bolster collective learning processes are essential, especially those that remove barriers, promote networking and nurture key regional institutions;<sup>12</sup>
- Customised support for high tech SMEs is preferable to more general support measures;<sup>13</sup>
- Efforts to encourage and facilitate spin-offs are vital, particularly those that take regional circumstances into account and those that focus on the provision of suitable premises and advice;
- Contextual differences between regions necessitate a customised approach to policymaking, with strenuous efforts in place to ensure complementarity between regional, national and EU-level initiatives.

Focusing even more closely on linkages within regional innovation systems, another study (1014) looked at technology transfer processes from university to industry in seven peripheral regions. It concluded that there were few strong links between universities and industry in peripheral regions, despite evidence in the literature that universities have the potential to play a critical role in the development of local economies. Numerous 'low-level' links (e.g. informal links between university personnel and individual firms and consultancy activities) did exist, but these took many forms and varied considerably in both type and importance from one setting to another. Academic links with industry tended to take the form of contract research and consultancy rather than involvement in licensing and spin-offs.

Although links did exist between some universities and larger companies, links with SMEs were constrained by a reluctance on both sides to interact. Cultural differences between the academic and industrial communities and antagonistic reward systems constituted the main barriers to discourse and technology transfer, while the prospect of increased funding via links with the private sector was the main incentive for academics to form industrial links.

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<sup>12</sup> Another TSER project (1061) looking at SME policy and the regional dimension of innovation similarly concluded that the organisation of strategic co-operation among small firms and local actors within regions was a policy imperative. The importance of networks in new product development and the case for policies supporting them were also argued in TSER 1066.

<sup>13</sup> TSER 1061 stressed the importance of customised measures aiding the process of knowledge internalisation, specifically the absorption by firms of knowledge generated outside the firm and the adaptation and exploitation of existing knowledge within firms.

There was little evidence to suggest that industrial liaison offices (ILOs) played an effective role in stimulating linkages. In many university settings, ILOs were marginal, under-funded administrative units performing low-level tasks on a reactive basis. Successful linkage strategies were either serendipitous in nature or a consequence of highly customised approaches based on thorough analyses of stakeholder capacities and needs.

One of the main policy implications of TSER 1014 was that considerable scope existed for schemes designed to help single or regional clusters of universities to evolve customised technology transfer strategies via comprehensive and detailed appraisals of the needs of local academics, industrialists and other major stakeholders in regional economies. Another was that efforts were needed to increase the visibility and efficacy of industrial liaison offices, perhaps via accreditation schemes and networking initiatives that facilitate the spread of best practice. The study also noted that initiatives attempting to break down some of the cultural barriers and increase mutual familiarity between academia and industry would benefit from the existence of easily accessible best practice exemplars. Finally, the study suggested that attempts to encourage the formation of spin-off companies from universities should be preceded or complemented in some settings by shorter-term efforts to stimulate other forms of collaboration and interaction.<sup>14</sup>

On a pragmatic note, one TSER study (1061) contained a useful overview of the range and appropriate application areas of policy instruments to support the innovation-related activities of small firms within regions. It distinguished between firm-oriented policies focusing on innovation and learning within firms on the one hand, and region-oriented policies focussing on interactions between small firms and other actors within regional innovation systems on the other. It also made a distinction between policies that concentrate on resource allocation and those that focus on learning and improvements in the way firms do things (so-called behavioural additionality). It noted that most policies tend to be 'firm- and allocation-oriented', with far fewer policies capable of characterisation as 'region- and learning-oriented'. In terms of future policy developments, therefore, the study emphasised the need for a far greater reliance on policies geared towards interactive learning within regional systems.

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<sup>14</sup> Another TSER project (1062) concerned with the process of 'collective invention' in Europe also noted that there was scope for new instruments to allow firms to create institutions for solving not only R&D problems, but also a much broader range of collective action problems encountered during the production of goods, resources and knowledge.

## 4 Public Research Systems

Within national and regional innovation systems, the role of public sector research systems is of particular interest, since the health of this 'science base' is intimately related to the health of the system as a whole. One TSER project (1036) thus set out to compare the changing organisation and structure of public research systems across Europe, with a view to examining how policies in this sphere actually affected the practice and progress of scientific activities. As a focus, the study concentrated primarily on changes in civil research structures and on the impacts of policies in areas vital to public health and safety.

The study revealed a set of converging pressures for change in public sector research systems with differentiated responses across countries in line with the position that innovation systems are context-specific and path dependent. After a period of expanding budgets for public sector science in the 1960s, many countries either reached national funding plateaus or experienced only modest expansion. The increasing importance of scientific and technological developments in areas such as information and communication technologies, biotechnology and new materials, many of which called for new skills, instrumentation, ways of working and – naturally – financial resources, then put pressure on public sector research budget holders to reallocate resources to prioritised areas of industrial and, to a lesser extent, social relevance. It also gave rise to support for collaborative research initiatives designed to encourage university-industry links and provide organisations with access to complementary assets and skills. Relevance complemented excellence as a selection criterion in the competition for resources, and the diverse set of institutions responsible for performing public sector research (universities, government laboratories, public and semi-public research institutions etc.) increasingly competed for these scarce national resources (with universities gaining ground over other types of institution) and sought out other internationally available sources, particularly the EU Framework Programmes and the Community Structural Funds. They also responded via the adoption of a set of management changes in line with the new environment in which they were operating. These included a greater emphasis on sound accounting practices, evaluation, foresight activities and strategic planning, as well as on new procedures to deal with university-industry links, technology transfer, intellectual

property rights and spin-offs.<sup>15</sup> Changes in employment conditions also occurred, with less tenure and more short-term contract research in evidence. There were fewer changes of a structural nature, however, with universities tending to retain disciplinary modes of organisation despite the pressures for interdisciplinary modes to be adopted.

In turn, all these changes have given rise to a new set of pressures and concerns that are – or should be – exercising policymakers. In the first instance, the preoccupation with industrial relevance has the potential to divert resources away from more basic research, which often has excellence as the sole selection criterion. Secondly, resources may be diverted away from research that has a broader social relevance, e.g. research oriented towards the resolution of health and social welfare issues. Thirdly, the blurring of missions resulting from multiple types of institution competing for the same scarce resources also has the potential to lead to square pegs filling round holes, with some universities, for example, particularly ill-suited to servicing the needs of local SMEs. Changes in the working conditions of staff, an increased focus on shorter-term applied research and less autonomy in the choice of research tracks can also deter potential new recruits from following a career in science.

The policy imperative in this situation, however, does not involve a race to turn the clock back or stem the tidal flow of change that public sector research systems have witnessed. Rather, the task now is to ensure that decisions concerning the future of public research systems are informed by the results of this and other studies. Governments intent on maintaining a focus on industrial relevance will need to ensure that mechanisms are in place to counterbalance some of the adverse effects noted above, while others wishing to support curiosity-oriented basic research, industrially-relevant work and other socially-desirable research will need to invoke additional mechanisms to raise the needed finance, e.g. via the constitution of a variety of new public-private partnerships.

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<sup>15</sup> Another TSER study (1101) observed that new practices of funding, evaluation and priority setting were making inroads at both a policy level and at the level of the organisational culture of universities and research organisations, though full institutionalisation amongst the latter was still some way off in many of the Member States of the EU.

## 5 Innovation Systems and Enlargement

The process of enlargement, particularly the incorporation of the post-socialist countries of Eastern Europe into the EU, was never going to be easy. The vast disparities between the economic regimes in place prior to the 1990s made this inevitable. The role of science, technology and innovation within these different environments also varied considerably, and it was only to be expected that these activities and the roles they played within each economic milieu would also evolve during the phase of post-socialist reconstruction. It was also anticipated that the policies needed to effect the subsequent entry of some countries into the EU would largely depend on the pace and direction of this evolution. TSER studies spanning this territory (e.g. 1008, 1009), particularly one looking at the role of science and technology systems in Eastern Europe during the post-socialist transition phase (1008), were thus particularly timely.

Specifically, the project reviewed restructuring in Eastern Europe and focused on the integration of science and technology systems into the industrial fabric, with a view to improving policy making in this arena. It noted that the economic and industrial restructuring that had taken place in the post-socialist era was dramatic. In particular, it had involved abandoning the vertical integration of production in many sectors, the opening up of domestic markets and new inflows of foreign investment, with economic growth in the early restructuring phase linked to different forms of firm-based learning in novel economic environments and wholesale changes in the structure of resource allocation (see also 1009 for a detailed account of such developments in Hungary).

This growth was not directly linked to science and technology developments. The struggle to survive in new economic circumstances had led to the neglect of links between the science base and industry (where these had existed) during the first stages of the transition process. High R&D potentials in many countries were undermined by low investment in this early phase (again see 1009 for an account of how the S&T infrastructure was downgraded), with the reintegration of science and technology systems into the industrial and economic mainstream progressing at different rates in different groups of countries. In particular, this reintegration was relatively fast in one group of countries (Poland, Czech Republic, Hungary, Estonia, Slovenia), moderate in another (Latvia, Slovakia, Lithuania, Romania), and slow in a third group (Moldova, Bulgaria, Russia, Belarus, Ukraine).

These differences in the pace of reintegration implied the need for different sets of policies in order to maintain the drive towards modernisation and knowledge-based economies underpinned by R&D and innovation. In terms of international co-operation, for example, the pressing need for the third group of countries was for an exchange of experiences concerning the organisation of science and technology activities in advanced economies and the formulation of relevant science, technology and innovation policies. In contrast, within the first group of countries, the need was for more intensive co-operation at all levels of the international governance of scientific and technological activities in the build up to their accession into the EU.

Common to all three groups, however, were specific policy needs in a number of key areas. These included the need to rethink and remodel the role and position of industrial R&D institutes within individual economic environments; the need to invoke public-private partnerships in the creation of domestic science and technology infrastructures, with the 'customers' of scientific and technological services shaping their focus and delivery by contributing to the costs of these services; the desperate need to stimulate both the supply and demand sides of the equation for vocational training; and the need to strengthen regional approaches to the development of sound innovation systems in order to ensure the entry of SMEs in particular into regional, national and international supply networks.

Another critical point was made by TSER 1009, which reviewed science and technology policies in both transition and developing countries. This study emphasised that the most important determinant of S&T success is industry's own investment in, and enthusiasm for, technological activity, not the existence of supportive infrastructural institutions *per se*. Technology push is not enough: firms have to provide the demand for S&T support services, and a key role for policy is to stimulate this demand where it is low or non-existent by helping to create a technology or innovation culture, most notably via awareness schemes and other direct policy measures enabling firms to access and perform technology-related activities.

## 6 Innovation Systems, Globalisation and ICTs

Innovation systems at various levels, whether international, national or regional, give rise to changes in the broader social and economic environments in which they are located. In turn, these innovation systems are themselves affected by the resultant changes in these macro-environments. The massive changes induced by the increasing pervasiveness of information and communication technologies (ICT), especially those affecting globalisation and employment and cohesion within the EU, were the focus of a number of TSER projects (e.g. 1005, 1064, 1070, 1076, 1103, 1119), including one particularly seminal project (1005).

This study demonstrated how the diffusion of IT and increased access to information had been one of the main drivers of the regulatory changes and liberalisation underpinning the phenomenon of globalisation.<sup>16</sup> Although this had not led to significant changes in the overall magnitude of trade and capital flows, it had led to important changes in the structure and patterns of such flows across the globe. In particular, it had led to major changes in the organisation of a multitude of processes at the firm level (e.g. in the organisation and location of production and research as well as distribution, marketing and sales) and to major changes in the demand for new skills and patterns of employment.

In Europe, however, the ways in which national economic and innovation systems responded, or failed to respond, to the stimulus of technological change in recent times are now posing policy problems. Increased international trade and market integration allowed Europe to catch up with the USA in the immediate post-war period. The USA was the first to move, however, to an economy dominated by science-based industry – itself the precursor of what we now call knowledge-based societies – and Japan and the Asian NICs (Newly Industrialised Countries) were quick to follow. This was not the case in Europe. European integration favoured natural resource-based and scale-intensive industries, which in turn led to a pattern of specialisation not particularly dominated by science-based industry. In addition, especially compared to the USA, the ICT sector was

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<sup>16</sup> TSER 1076 also noted that the fall in costs of telecommunication had facilitated the diffusion of codified knowledge, and that the rapid, cumulative expansion of the codified knowledge base was the most salient characteristic of the development of a modern economy based on knowledge.

and continues to be moribund, the diffusion of ICTs is sluggish, and the onset of a knowledge-based society remains protracted. Tellingly, Europe has also been slow to adjust the educational supply to the demand for different skill sets within knowledge-based economies, and there is a distinct danger that European innovation systems have ossified into behavioural patterns ill-suited to the objective set at Lisbon of becoming the world's leading knowledge-based economy by 2010.

Given that there have been no radical shifts in this situation since the publication of the results of TSER 1005 in 2000, the wide-ranging policy recommendations it contains are still pertinent to current policy formulation. These can be summarised as follows:

- The EU needs to adopt a more expansionary macroeconomic policy, but with supply-side measures in place to match those on the demand-side;<sup>17</sup>
- The EU should lead the way in terms of the early adoption of regulatory changes facilitating the production and diffusion of both ICTs and other key technologies;
- As well as supporting scientific and technological research, the EU should place greater emphasis on innovation policies which also stress the importance of support for the take-up and diffusion of ICTs and other new technologies;<sup>18</sup>
- The threat of increased disparity between 'information rich' and 'information poor' regions within a knowledge-based economy, together with an appreciation that Europe can only support a limited number of 'Silicon Valley look-alikes' (i.e. regional growth poles comprising dense conglomerations of ICT-related firms and research centres), should stimulate new policies encouraging new patterns of differentiated but inter-linked regional specialisations;
- Labour market policies are needed both to support economic growth via competitive advantage and to cut unemployment via job creation in socially desirable sectors.

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<sup>17</sup> Another TSER project (1055) concluded that the main objective of such growth policies should be to smooth transitions induced by technological changes or any other type of shock.

<sup>18</sup> TSER 1019 highlighted the need for diffusion policies geared towards public trials and social learning, since there was ample evidence that the eventual uses and utility of ICTs, multimedia products in particular, were often far removed from supplier presumptions.

## 7 Innovation Systems and European Welfare

Where does an innovation system end and the socio-economic context in which it exists begin? This may seem a trivial issue, but from both analytical and policy perspectives it is not, for too narrow a definition restricts the focus of both analysis and policymaking to a limited range of scientific and technological activities, and too wide a focus can result in such activities becoming mere noise in the system. The approach in one TSER project (1077), therefore, was to adopt a moderately broad notion of a Social System of Innovation and Production (SSIP) with the following well-defined components or sub-systems:

- Volume and funding of R&D activities
- Scientific specialisation;
- Industrial R&D profile;
- Technological specialisation;
- Economic activities profile;
- Labour market and social protection;
- Education;
- Macroeconomic and social performance.

Indicators were then developed for all these systems and patterns and trends analysed for 14 European countries, Australia, Canada, Japan and the USA. The analysis distinguished between seven different types of SSIP, though at lower levels of definition it was possible to identify just two distinct groupings, a continental EU grouping (minus the UK) and a non-EU grouping (including the UK). The EU grouping members possessed similar:

- Labour market and social protection characteristics;
- Egalitarian income distributions;
- Roles for government services in GDP;
- Shares of industry in economic activity;
- High proportions of national R&D in 'classical' industrial sectors such as automobiles, chemistry and equipment goods;
- Scientific specialisation in physics and chemistry.

There were also some differences, mainly in terms of GDP per capita, unemployment rates, R&D funding levels and education activities, but the EU -group was largely characterised by its concordance with a 'European Welfare' model, whereas the non -EU grouping was typified by its commensurability with a 'Market -driven' model, with less protective employment and social welfare regimes and more unequal income distributions.

In terms of trends over time from 1986-96, this pattern grew more emphatic, with a greater divergence between the two groupings along dimensions such as the equality (or inequality) of income distributions. In parallel, there was increasing convergence within the EU grouping in terms of egalitarian income distributions and the robustness of employment and welfare protection. There were no overt differences, however, between the two groupings as far as productivity and employment performance were concerned, and both groupings appeared to be evolving towards knowledge -based societies characterised by higher education enrolment, increased public and private R&D and S&T activity, and a larger share of business services, biotechnology and ICTs in economic activity.

The study concluded that the process of European integration had contributed to some of these changes. Specifically, it stressed that integration had facilitated the harmonisation of social protection and labour legislation and thus aided the process of convergence and improvement within the EU, and that integration had also allowed the EU to keep abreast in terms of the social and regulatory changes needed to stay on the path to knowledge -based societies.

On the basis of its analysis, the study outlined a number of policy imperatives. The first was that the EU -grouping had to keep increasing certain activities (R&D intensity, educational enrolment etc.) if it wanted to stay on course for a knowledge -based society. A second imperative was for the EU -grouping to build on the opportunities inherent in the 'European Welfare' model, noting that socially protective labour conditions can attract high skilled workers and researchers and that income equality can give rise to a large demand for high quality goods and services. Another TSER project (1064) focusing on the impact of ICTs on work practices also warned of the dangers of a dual labour market and social exclusion unless specific measures are in place to counter some of the adverse effects of the spread of ICTs in purely market -driven contexts.

Data for subsequent years, however, have added a new dimension to the policy debate. The gap between the EU and the USA has grown in terms of both R&D intensity (largely a consequence of R&D investment in ICTs in the USA prior to the bursting of the dot.com bubble) and labour productivity (the result of a close relationship between R&D intensity and labour productivity in the USA over the period 1995 -2000).<sup>19</sup> This situation will have to be rectified if progress towards a knowledge -based society is to be maintained, and policy initiatives will need to include determined efforts to raise R&D intensity levels (see 1077), to promote the diffusion of ICTs (see 1005) and to rectify the structural dependence of the EU on ‘classical’ industries (see 1004).<sup>20</sup> But if the performance gap with the USA is due in part to the relative success of the US market -based model over the EU welfare model, then EU policymakers may be faced with a stark choice: either abandon the European welfare model and adopt a market-based model in order to keep pace with the USA; or stick with the welfare model and forge an entirely different form of knowledge -based society, i.e. one in which the benefits of the EU welfare model continue to be highly prized by European society.

## 8 Strategic Intelligence

Policy formulation based on a fine understanding of innovation systems and their dynamics requires a great deal of ‘strategic intelligence’. Most of the TSER projects were geared towards the collection and analysis of such intelligence (e.g. TSER 1007, which was entitled ‘Strategic Analysis for European S&T Policy Intelligence’), while for other projects the primary focus was methodological in nature: specifically the improvement of the methods and processes used to collect, analyse, interpret, disseminate and exploit strategic intelligence. TSER 1006, for example, comprised a review of the conceptual foundations and empirical usability of existing science and technology indicators and the development of new indicators to aid understanding and policy formulation. The need for this re-examination of the appropriateness and utility of existing indicators stemmed from recent advances in both innovation systems theory and the increased stress placed on innovation policy in the pursuit of social and economic

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<sup>19</sup> Soete *et al* (2002), ‘Benchmarking National R&D Policies: The Impact of RTD on Competitiveness and Employment (IRCE)’, STRATA -ETAN Expert Working Group, Brussels: European Commission

<sup>20</sup> Another TSER project (1059) even suggests that policies designed to facilitate restructuring within such sectors (e.g. chemicals) could lead to increased R&D intensity at a sector level.

well-being. The study concluded that the areas in which new indicator development was most needed corresponded to a series of policy concerns about knowledge creation, knowledge dissemination and knowledge absorption and use. For example, it suggested that innovation surveys (such as the Community Innovation Survey) should accommodate indicators that capture knowledge diffusion as well as knowledge creation as an important part of the innovation process. In essence, this entails the use of indicators to describe both innovation through creative activity and innovation as the result of diffusion processes.

TSER 1104 was also concerned with indicator development, specifically with the thorny problem of measuring 'intangible' assets at the level of the firm, while one of the main contributions of TSER 1107 was the elaboration of a simulation model designed to throw light on the functioning and dynamics of innovation networks. The project with perhaps the most far-reaching implications for the practice of policymaking, however, was one that focused on the processes by which strategic intelligence is generated, disseminated and absorbed. TSER 1013 comprised a network concerned with advanced science and technology planning processes. Its first task was to review the use of 'conventional' tools in this sphere, namely evaluation exercises to review the efficiency, effectiveness and impact of past practices; technology foresight exercises to review the potential and feasibility of future options; and technology assessment to assess the implications of adopting particular courses of action. The network concluded that these were necessary tools that had evolved considerably over the last twenty years or so and were now embedded in many policy formulation contexts at international, national and regional levels across the EU, though the extent of this embeddedness varies considerably from one context to another. It noted that improvements in these practices could still be made and suggested a number of ways in which they could be used in conjunction with each other. The most important policy recommendation, however, was that the results of these and similar practices should be made widely available within the framework of a distributed intelligence network. Currently policymakers in different parts of the world independently call for localised strategic intelligence activities to be customised to their own particular needs. The report of the network argued, however, that the results of these exercises have a didactic value in other contexts and that processes enabling the collective initiation and sharing of these results need to be established. In particular, the recommendations of the report presaged subsequent benchmarking initiatives within the context of the Open Method of Co-ordination by suggesting that the European

Commission had, and continues to have, a catalytic role to play in the ‘soft co-ordination’ of Member States’ activities in this arena.

## **9 Implications of the TSER Work for the Five-Year Assessment Exercise and Future Policy**

The endeavours of the TSER researchers have illuminated the way innovation systems function within the EU and provided much food for thought for both policy analysts and the policymaking community. But what are the implications of this body of work for the Five-Year Assessment of the Framework Programmes?

### **9.1 Assessing the Past**

The most important implication is also the most unpalatable. The remit of the next Five-Year Assessment, due to report in 2004, will be to assess Framework activities spanning all of FP5 and the earliest phase of FP6. The distinguishing feature of FP5 – and hence a primary focus of the assessment exercise – was its emphasis on the achievement of socio-economic goals as well as the attainment of traditional goals related to scientific excellence and improved competitiveness. With high-level goals such as these, there are intense pressures of political accountability to demonstrate that FP5 has indeed led to significant socio-economic impacts. The insights of the TSER researchers, however, demonstrate vividly how difficult this will be. This stems directly from an appreciation of the role R&D sub-systems play within broader innovation and economic super-systems. Although R&D sub-systems are vital components of innovation systems, overall system dynamics and performance are dictated by many other factors, with the immediate implication that the explicit form of the relationship between R&D performance and innovation system and economic performance is difficult to ascertain. Although it is sometimes possible to demonstrate a loose relationship or association over time between R&D spend and aspects of macro-level economic performance such as competitiveness, productivity and employment, the complexity of interactions within innovation systems makes it almost impossible to demonstrate a causal relationship between specific R&D spend and macro-economic performance, especially when the R&D spend in question (e.g. the amounts spent on Framework R&D) constitute only a

very small percentage of overall R&D spend within the innovation system of interest (e.g. that of the EU as a whole).

Demonstrating that individual R&D projects can and do have specific socio-economic impacts is also fraught with difficulties, as are attempts to measure their extent and the quantitative form of input/output/impact relationships. The absence of simple linear models linking R&D and socio-economic performance and the existence of multiple feedback loops in more complex innovation system models means that there are both **direct** and **indirect** ways in which specific R&D inputs can affect socio-economic environments. Whereas it is possible on occasion to establish the existence of **direct** links at a project level between specific R&D inputs (financial and human resources), R&D outputs (knowledge, publications, patents), organisational outcomes (increased productivity, commercial sales, new markets), and broader socio-economic impacts (market expansion, policy development, environmental well-being etc.), demonstrating the existence of **indirect** links is much more problematic. Moreover, even when direct and indirect links can be established, attempts to quantify these relationships in any meaningful way are confounded by the causality and attribution problems associated with complex social systems, i.e. systems in which specific inputs lead to multiple impacts, and specific impacts are a consequence of multiple inputs. The implication is that whereas simple quantitative statements can be made about R&D inputs and immediate outputs (e.g. 10 projects costing a total of €20 million led to 100 publications by the end of the projects and a further 200 over the following three years), the precision and confidence with which such quantitative statements can be made declines very rapidly as one progresses from ‘first circle’ impacts (i.e. impacts on the research teams involved in projects, which include increased know-how, expanded research networks etc.), through ‘second circle’ impacts (i.e. impacts on the organisations to which these research teams belong, e.g. improved productivity, product developments, increased sales etc.), and through to eventual ‘third circle’ impacts on the broad socio-economic environment.

Efforts to establish quantitative assessments of the wider socio-economic impacts associated with upstream R&D inputs are not only difficult, however, they are also inappropriate. Whenever a policy initiative is framed in terms of the achievement of high-level goals such as improving competitiveness and social welfare, the dictates of accountability typically provoke a knee-jerk response demanding that the ‘bang for buck’ in these spheres is measured, but such attempts are based on a misconception. They are based on the rather simplistic notion that policy initiatives are themselves predicated

upon the existence of simple causal chains between inputs and ultimate downstream impacts. In reality this is rarely true, and it is certainly not true for collaborative R&D programmes such as the Framework Programmes. Their rationale derives from an appreciation that policies are often needed to stimulate many of the knowledge -related interactions between the stakeholders of an innovation system if it is to function effectively. The basic presumption is that there is a ‘market failure’ which has to be rectified by public sector intervention, not only in terms of increasing the amount of R&D which is socially optimal, but also in terms of improving the ability of firms to access and exploit important sources of information and knowledge. Collaborative R&D programmes aim to rectify these ‘failures’ by facilitating the creation and expansion of knowledge bases via the sharing of complementary assets between researchers in universities, research organisations, firms and other ‘knowledge agents’. Certainly there is the presumption that these ‘knowledge goals’ and ‘networking goals’ will ultimately allow firms to exploit their enhanced knowledge bases in an effective and efficient manner, but it is also recognised that the path to such exploitation is not necessarily direct, with many other variables likely to affect both the economic fortunes of the firms involved and the sectors and markets within which they operate.

All this has important implications for evaluation. The most important is that efforts to determine goal attainment should focus primarily on those goals related to the rationale underpinning collaborative R&D (namely knowledge and networking goals and the rectification of market and information failures), which in turn implies that the most important evaluation issues revolve around the degree of information sharing and learning that occurs in projects, the nature and extent of improved knowledge and networking capabilities, and the degree to which knowledge and networking capabilities have been enhanced over and above their levels prior to the public intervention. In the terminology used earlier, these are ‘first circle’ issues and impacts.<sup>21</sup>

Next on the list of priorities come achievements in terms of exploitation -related goals, with the twin provisos that downstream exploitation and resultant impacts on an organisation’s productivity, competitiveness, sales etc. (i.e. ‘second circle’ impacts) are not only difficult to establish in any meaningful quantitative sense, but are also affected

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<sup>21</sup> In assessing goal attainment in these spheres, evaluation panels should note that the degree of eventual goal attainment reflects not only the prowess of project participants, but also the intrinsic ability of projects to meet these goals and, hence, the soundness of overall programme design and the efficacy of initial project selection procedures.

by many variables other than the quality and potential of R&D project achievements. It should also be noted that the direct commercialisation of collaborative R&D results is rarely a first order goal of participating firms, since R&D projects that are intended to lead directly to marketable outputs are typically carried out in-house and not in collaboration with other partners. It is still possible, however, to use tools such as questionnaire surveys to identify the relatively small proportion of projects with direct commercial returns and to conduct more detailed case studies on these in order to establish the nature and extent of the returns. For most projects, however, it is more important to ascertain how 'first circle' impacts improve the prospects for indirect 'second circle' impacts than it is to measure relatively small or non-existent 'second circle' effects of a direct nature.

'Third circle' impacts on the broader socio-economic environment are the most difficult to measure, but this does not mean that they should be neglected entirely. The most important task here is not to establish extremely tenuous causal links and measure exceptionally small impacts (the equivalent of measuring the impact of a single butterfly's flapping wings on overall wind speed and direction an hour later), but to establish whether or not perceived impacts, however small, are in line with overall expectations and the rhetoric of high-level socio-economic goals.

The importance of the socio-economic and innovation system contexts in which R&D policy initiatives are located means that it will also be necessary for the Five-Year Assessment Panel to track overall changes in broad socio-economic indicators spanning EU, national and regional employment levels, trade flows, environmental well-being, social welfare etc. This should not be seen as part of a vain attempt to establish causal links between system level performance and individual project results (mere 'noise' in the system), but as a check that the rationale for the Framework Programmes remains sound. It should also be possible to check whether perceived impacts, aggregated up to regional or national level, are in line with the expectations and needs of individual regions and countries. This kind of analysis is currently hindered within Commission and Member State circles because of a degree of sensitivity concerning the presentation and publication of Framework results on a country-by-country basis, but it will be important to rectify this if impacts at the level of regional and national innovation systems are to be explored.

Benchmarking activities involving the collection and comparison of regional and national statistics on the movement over time of socio-economic indicators will also play an increasingly important role in the evaluation of Framework Programmes given the rationale underpinning FP6 and the establishment of the ERA. As noted in the introduction to this report, there is now a concerted effort to reconfigure the science, technology and innovation landscape within Europe, and the key role of any future evaluation of FP6 and ERA will be to ascertain whether or not this restructuring is occurring and how FP6 has contributed to this process (though with all the same provisos as above concerning causality and attribution). Given the start date of FP6 and the time spans involved in collecting all the necessary data relating to structural change, it will not be possible during the next Five-Year Assessment – due to commence in 2004 – to explore the impact of FP6 on structural change, but it will be important during this exercise to establish baseline indicators which can be used to benchmark overall system performance in the years to come. These indicators should cover all the areas likely to be influenced by FP6, including human mobility patterns, science infrastructure development, the distribution of both sources of research funding and their recipients, the concentration and consolidation of resources into networks of excellence, the establishment of critical masses in strategic areas, and the development of regional clusters of research and innovation actors.

The efforts required both to establish these baselines and to collect and monitor subsequent developments are significant. To date the organisation of the Five-Year Assessment of the Framework Programmes has been the responsibility of an evaluation unit within the Commission, which has collected and provided background information to the Main Panel charged with performing the assessment. In future, however, it will be imperative to enlist Member States in the task of collecting and compiling all the necessary benchmarking data at national (and regional) levels and to ensure that adequate procedures are in place for the transmission of this material, first to the Commission evaluation unit and thence to the Five-Year Assessment Panel.

## **9.2 Thinking About the Future**

The timing of the Five-Year Assessments is such that they constitute a formal input into the planning phase for future Framework Programmes. The next assessment exercise, therefore, will feed into the formulation of the Seventh Framework Programme (FP7, if

this structure and terminology are perpetuated). The assessment report will thus contain both evaluations of past behaviour and suggestions for future policy, with the latter split into suggestions which can be taken on board during the remainder of FP6 and those which should influence the design of FP7 and other initiatives likely to affect the course of science, technology and innovation-related activities in the EU. What lessons for the future can the Five-Year Assessment Panel draw, therefore, from the work conducted by the TSER community on the functioning of innovation systems? Table 1 summarises the main findings of this body of work, together with their implications for policy.

**Table 1 Main Findings and Policy Implications of the TSER Projects**

Innovation System Concepts, Performance and Policy	
Main Findings	Policy Implications
<ul style="list-style-type: none"> <li>• The key feature of an innovation systems approach is its emphasis on the interaction between the actors and institutions within a system</li> <li>• The institutional frameworks set up to promote one set of goals, e.g. competition, can be antithetical to the attainment of innovation-related goals</li> <li>• Innovation policies are often servants of other policies and innovation is affected both by targeted policies and policies which affect framework conditions</li> <li>• Policies aimed at improving framework conditions have an appreciable impact on innovation and economic performance</li> <li>• The development paths of innovation systems are context specific and path dependent</li> <li>• Innovation policy formulation and implementation vary from one national setting to another within the EU, with much less attention paid to regional or EU-level issues</li> <li>• EU industry has become locked into technological trajectories that prioritise labour-saving process innovation in ‘classical’ industries over growth creating product innovation in high R&amp;D intensive sectors</li> <li>• The preference for credit-based financing in Europe over equity-based financing favours process innovation rather than product innovation and new firm formation</li> </ul>	<ul style="list-style-type: none"> <li>• The centrality of interaction within an innovation system implies that innovation policy has to emphasise the importance of interactive learning</li> <li>• Development policies for whole innovation systems have to comprise a mix of policies tackling specific interactions via organisational and institutional change</li> <li>• Competition and technology procurement policy should strike a balance between promoting competition and encouraging the close user-supplier relationships needed for innovation</li> <li>• Policies tackling framework conditions are an important component of effective policy mixes</li> <li>• Innovation policies, like innovation systems themselves, are context specific and path dependent, and have to be based on empirical analyses, intelligent comparisons, experimentation and evaluation</li> <li>• Although it is fitting for national policies to differ across the EU, greater efforts are needed to tackle EU-level issues and customise policies to regional needs</li> <li>• Policies supporting structural change in the direction of more R&amp;D-intensive and less process innovation oriented sectors are needed in the EU</li> <li>• Improved access to capital is needed in order to stimulate new high-tech SMEs and product innovation</li> </ul>
Regional Innovation Systems	
Main Findings	Policy Implications
<ul style="list-style-type: none"> <li>• As with national innovation systems, networking and interactive learning are vital components of healthy systems</li> </ul>	<ul style="list-style-type: none"> <li>• Network-oriented innovation policies designed to improve collective learning processes are essential, especially those that remove barriers to innovation,</li> </ul>

<ul style="list-style-type: none"> <li>• Most regional innovation policies are concerned with the simple allocation of resources and focus on innovation within individual firms</li> <li>• Key drivers of innovation at a firm level in the EU are attempts to lower costs, enhance quality and improve skills</li> <li>• Key barriers to innovation are scarcity of funding, the cost of researchers, lack of management time and low workforce skills and know-how</li> <li>• Local universities play an important though often under-developed role in innovation networks, especially in terms of links with large firms and as a source of spin-offs and personnel for high-tech SMEs</li> <li>• Industrial Liaison Offices are often marginal, under-funded units that do not play an effective role in stimulating linkages between universities and industry</li> <li>• Strong regional governance is a necessary (though insufficient) condition for strong regional innovation systems</li> <li>• The independence of regional innovation systems in trade or knowledge competence terms is untenable</li> <li>• The formulation of regional innovation policies requires a broad appreciation of the needs of stakeholders and the feasibility of different development paths</li> </ul>	<p>promote networking and nurture regional institutions</p> <ul style="list-style-type: none"> <li>• More policies are needed which focus on regional interactions and concentrate on improving the ways firms do things</li> <li>• Innovation policies should help firms achieve not just technology-related goals but also broader goals related to cost reduction, skill enhancement and quality improvement</li> <li>• Policies aimed at improving local innovation networks should include a focus on large firm-university links, complemented by efforts to enhance the interaction of SMEs with local innovation infrastructures, including universities</li> <li>• Efforts are needed to increase the visibility and effectiveness of Industrial Liaison Offices</li> <li>• Efforts to promote the centrality of innovation to regional development are needed even when local governance structures are strong</li> <li>• Efforts to promote regional innovation systems have to focus on links with external systems as well as internal linkages</li> <li>• Support is needed for local efforts to determine regional needs, capabilities and innovation strategies</li> </ul>
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Public Research Systems	
Main Findings	Policy Implications
<ul style="list-style-type: none"> <li>• Funding for public research bases has tended to level off over the past decade in many countries, even though developments in areas such as ICTs, biotechnology and new materials have increased the demand for funding</li> <li>• Competition for scarce resources has led many research organisations to adopt new roles and attempt to improve management practices</li> <li>• A preoccupation with industrial relevance has the potential to divert resources away from both basic research and work of a broader social relevance</li> </ul>	<ul style="list-style-type: none"> <li>• Competition for scarce resources means that excellence as a research selection criteria has to be complemented by other criteria emphasising industrial and/or socio-economic relevance</li> <li>• Policy initiatives are needed to help individual research organisations to adjust to the demands of the new research environment</li> <li>• Difficult choices lie ahead concerning the balance between basic research, industrial research and research with broader social relevance unless research funding can be expanded</li> </ul>

Innovation Systems and Enlargement	
Main Findings	Policy Implications
<ul style="list-style-type: none"> <li>• Science and technology infrastructures were neglected during the dramatic restructuring which took place in Eastern European countries in the first phase of the post-socialist era</li> </ul>	<ul style="list-style-type: none"> <li>• The different rates at which science and technology infrastructures are being reintegrated into revamped economic frameworks call for different policy mixes</li> <li>• EU support for 'slow' countries should focus on</li> </ul>

<ul style="list-style-type: none"> <li>• Subsequently, science and technology systems within individual countries are being reintegrated into the industrial and economic mainstream at different rates (fast, moderate and slow)</li> </ul>	<p>exchange of experiences concerning the organisation of S&amp;T activities and the formulation of policies, whereas policies for the ‘fast’ countries should focus on more intensive co-operation at all levels of S&amp;T governance</p>
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Innovation Systems, Globalisation and ICTs	
Main Findings	Policy Implications of countries
<ul style="list-style-type: none"> <li>• The diffusion of ICTs and increased access to information has been one of the main drivers of the regulatory changes and liberalisation underpinning globalisation</li> <li>• In Europe, existing patterns of industrial specialisation and comparatively weak responses to the opportunities presented by ICTs have combined to retard the evolution of knowledge-based societies</li> </ul>	<ul style="list-style-type: none"> <li>• Policy initiatives facilitating the production and diffusion of ICTs and other key technologies are urgently needed</li> <li>• These include support for research and the early adoption of regulatory changes facilitating diffusion</li> <li>• The threat of an increasing gap between information-rich and information-poor regions should stimulate policies encouraging new patterns of differentiated but inter-linked regional specialisations</li> </ul>

Innovation Systems and European Welfare	
Main Findings	Policy Implications
<ul style="list-style-type: none"> <li>• The process of European Integration contributed to the development of a European ‘social system of innovation and production’ which is characterised by its emphasis on employment protection and social welfare</li> <li>• In contrast, the US system is more market-driven and has more unequal income distributions</li> <li>• Until the mid-1990s, both systems appeared to be evolving towards knowledge-based societies at a similar pace, though subsequent differences in the growth rates of R&amp;D intensity and labour productivity have seen the US draw ahead of the EU</li> </ul>	<ul style="list-style-type: none"> <li>• If the EU is to keep on track vis-à-vis the development of a knowledge-based society, it will be important to raise R&amp;D intensity, rectify the structural dependence on ‘classical’ industries, promote the diffusion of ICTs and generally nurture the development of a healthy EU innovation system</li> <li>• Efforts to keep pace with the USA may mean abandoning the European ‘social welfare’ model</li> <li>• Alternatively, a conscious policy decision to maintain an emphasis on social welfare should attempt to build on features such as the increased demand for quality goods which income equality can stimulate</li> </ul>

Strategic Intelligence	
Main Findings	Policy Implications
<ul style="list-style-type: none"> <li>• Innovation policies need to be based on a keen understanding of the structure, operation and dynamics of innovation systems</li> <li>• Evaluation, technology assessment and technology foresight exercises are indispensable tools in this arena</li> <li>• Localised exercises of this nature have great value in other settings if interpreted with care and sensitivity</li> </ul>	<ul style="list-style-type: none"> <li>• Developing an understanding of innovation systems demands considerable investment in the collection, transmission and assimilation of ‘strategic intelligence’</li> <li>• Via benchmarking initiatives and the use of the Open Method of Coordination, the European Commission has a catalytic role to play in the ‘soft co-ordination’ of intelligence generation and sharing activities</li> </ul>

The logic of the innovation system approach developed and advocated by the TSER research community and other innovation policy researchers and analysts should also be an important consideration when the Five -Year Assessment Panel contemplates the contemporary debate within Europe concerning the relative primacy of ‘excellence’ and/or ‘relevance’ as selection criteria for Commission -supported research activities. Historically, the Framework Programmes have always stressed the importance of scientific excellence as a selection criterion, though this has always been complemented by other criteria that emphasise relevance to the goal of increasing industrial competitiveness in Europe, and recent Framework Programmes have placed growing emphasis on relevance to a number of other socio -economic goals, including environmental health and social welfare. Of late, however, there have been calls in a number of quarters for excellence to reassert itself as the prime, if not the sole, selection criterion for work supported by DG RESEARCH, though it is not quite clear how this would operate in practice given that it would mean substituting a focus on particular strategic areas (governed by the relevance selection criteria) for a more thinly spread contribution to a larger number of areas. While it is not impossible to conceive of such a structure, any recommendations to proceed in this direction should be governed by a keen consideration of the desirability of such a formulation within the context of the EU innovation system as a whole. A key question is whether or not other policy initiatives would be able to provide support for projects deemed to be of great social relevance. If not, a gap could arise in the policy mix needed to sustain a European innovation system geared towards the needs of European society.

The breadth of this policy mix is critical. Many of the most important policy suggestions in Table 1 stem from the perspective that well -functioning innovation systems require component sub -systems both to function well themselves and to interact smoothly with other sub -systems. In simple terms, this suggests that the science base has to be strong and adequately linked to industrial research and technological capacity; that innovation in industry has to be finely attuned to the absorptive capacity and needs of markets; that consumers have to be educated to the point where they are able to appreciate and benefit from innovative goods and services; and that education systems also have to train sufficient skilled people to work within the science base, industry and the delivery systems for these goods and services.

Within the context of the EU, the Framework Programmes operate primarily at the interface between the science base and industrial research and technological capacity,

where they complement research activities funded at a national level and conducted by academics, and R&D and innovation-related work funded and conducted by the private sector. They thus occupy just a small space within the EU innovation system as a whole and constitute just a fraction of the activities within this space, though the avowed purpose of FP6 is to ensure that this small fraction catalyses and stimulates the restructuring and conduct of all activities within both the scientific and industrial R&D bases. For the EU innovation system to function well, however, many sub-systems other than those directly touched by the Framework Programmes have to function well too, including many education-related activities which fall within the brief of DG EAC, and a multitude of innovation and industrial development activities which are covered by the likes of DG ENTR, DG INFSO, DG REGIO, DG ECOFIN, DG COMPETITION etc. Moreover, all these activities and sub-systems have to mesh effectively with the scientific and industrial R&D bases that DG RESEARCH activities are meant to strengthen. While it is important therefore that the Framework Programmes (or similar initiatives) continue to bolster these capabilities (for all the evidence now points to the existence of a gap in R&D intensity between the EU and its competitors, especially in terms of private sector R&D spend), mechanisms also need to be in place to ensure that there are adequate links or bridges with other activities in other sub-systems. Crucially, this also implies the need for adequate linkages between the policies and policymaking bodies that govern these various spheres.

Whereas links between many of these bodies certainly exist, a question mark hangs over the adequacy of coherent policy formulation for the EU innovation system as a whole. Although it is fitting in any system of governance that different parts of the apparatus have different areas of responsibility, some way of linking and synchronising activities such that they are in harmony rather than conflict with each other is an imperative. Structures ensuring that this happens can take many forms, ranging from the heavy-handed co-ordination of centralised planning regimes to the much lighter 'concertation' structures that rely on inter-departmental committees to exchange information relevant to the realignment and fine tuning of contiguous policy initiatives. Current arrangements pertinent to EU innovation activities lie towards the weak end of the spectrum and arguably have to be strengthened considerably if research and innovation-related policies are to have a joined up feel about them.

One way of doing this would be to maintain the momentum established by the ERA initiative, which has done much to promote the need for restructuring within the EU and

has already stimulated a multitude of policy discussions (and actions) concerning the most appropriate ways of strengthening and improving the EU R&D base. By expanding the concept to include innovation and industrial development as well as research, the debate currently preoccupying many EU policymakers could be fruitfully expanded to discuss appropriate structures for the governance of a European Innovation Area, with the whole initiative conceived, perhaps, as a necessary plank in building the BRIDGE (Bridging the Research and Industrial Development Gap in Europe). The stage would then be set for a radical review not only of how Commission initiatives designed to strengthen the EU innovation system could be orchestrated, but also of the policy needs of the system as a whole and the roles of different actors at multiple levels of governance – EU, national and regional.

The involvement of multiple levels of governance in building the ‘BRIDGE’ is both necessary and inevitable. The work of the TSER research community lays great stress on the differences that exist between regional innovation systems across Europe and even national innovation systems, all following different trajectories and all having slightly different policy needs capable of being satisfied only via customised policy mixes. The policy imperative here, therefore, is to avoid the application at an EU level of ‘one size fits all’ policy solutions and to work towards the evolution of structures and solutions that satisfy local needs. Within the existing policy frameworks of DG RESEARCH, this could involve calls and selection criteria deliberately designed to satisfy the policy needs of selected countries or regions (e.g. a scheme designed to seed new research and industrial capabilities in the Accession countries via selection criteria which demand the compulsory inclusion of participants from these countries in a proportion of Integrated Projects or Networks of Excellence). Greater use could also be made of Article 169, which encourages and provides EU support for ‘variable geometry’ initiatives involving two or more Member States. It will also be important to encourage and support initiatives geared towards understanding the research and innovation needs of countries and regions. Similar initiatives over the years have been supported by DGs ENTERPRISE, REGION and INFSO (e.g. the RITTS, RTP and RIS initiatives, all designed to establish regional technology, innovation and societal needs and potential policy solutions), but the time is now ripe to expand both the concept and the level of activity, first via the more comprehensive coverage of research as well as innovation - related activities in these strategy formulation exercises, and second via their expanded use at various levels, e.g. single region; multiple contiguous regions; ‘virtual clusters’ of non-contiguous regions specialising in specific technology areas; whole countries; and

even clusters of countries within the EU. Such strategy planning exercises could be organised as joint initiatives between interested DGs, with follow -up support programmes also launched as joint ventures between these Directorates.

There is also scope for rethinking how future Commission structures handle the increasingly artificial divide between research and technological development (currently supported via the Framework R TD Programmes) and other innovation -related activities (supported via various initiatives under the aegis of DG ENTR, DG REGIO etc.). In order to build the BRIDGE, it may be necessary to construct a super Framework Programme spanning not only RTD but a mu ch broader range of innovation -related activities within the European Innovation Area. Within this structure, DG RESEARCH could still take responsibility for RTD activities, with DG REGIO, for example, taking the lead in the provision of support for regio nal innovation systems. The key difference would lie in the joint formulation across Directorates General of coherent policy agendas and co-ordinated work programmes capable of developing a strong EU innovation system.

# Appendix 1

## TSER Projects related to Science, Technology and Innovation Policy

Project Code	Coordinator & Institution	Project Title
SOE1-CT95-1004	Prof. Charles Edquist / Linköping University /SE	Innovation Systems And European Integration (ISE)
SOE1-CT95-1005	Dr. Luc Soete and Dr. Bart Verspagen /MERIT / BE	Technology, Economic Integration and Social Cohesion
SOE1-CT95-1006	Prof. Keith Smith / STEP Group / NO	Indicators and Data for European Analysis
SOE1-CT95-1007	Mr Rémi Barré / OST / Paris , FR	Strategic Analysis for European S&T Policy Intelligence
SOE1-CT95-1008	Dr. Slavo Radosevic / Science Policy Research Unit / UK	Restructuring and Reintegration of Science and Technology Systems in Economies in Transition
SOE1-CT95-1009	Dr. Sanjaya Lall/ Univ. Oxford / UK)	S&T Policies in Developing and Transition Countries: Reform and Technological Cooperation in Europe
SOE1-CT95-1010	Prof. Philip Cooke / Univ. Wales / UK	Regional Innovation Systems: Designing for the Future
SOE1-CT95-1011	Dr. David Keeble / ESRC / UK	Networks, Collective Learning and RTD in Regionally-Clustered High Technology SMEs
SOE1-CT96-1012	Mr. John Williams / TUC / UK	Sunshine Regions or Sunset Regions
SOE1-CT96-1013	Dr. Stefan Kuhlmann / Fraunhofer-Institut für Systemtechnik und Innovationsforschung / DE	Thematic Network on Advanced S&T Policy Planning
SOE1-CT96-1014	Prof. Dylan Jones -Evans / Univ. Dublin / IR	Universities, Technology Transfer and Spin -off Activities: Academic Entrepreneurship on the Periphery of Europe
SOE1-CT96-1015	Mr. Johan Hauknes /STEP Group / NO	Services in Innovation; Innovation in Services
SOE1-CT96-1016	Mr. Andrew Jamison / Lunds Univ. / SE	Public Engagement and Science and Technology Policy Options
SOE1-CT96-1017	Dr. Peter Wood / Univ. College London / UK	The Strategic Role of Knowledge Intensive Services for the Transmission and Application of Technical and Management Innovation
SOE1-CT96-1018	Prof. Dr. Friedrich Schmidt -Bleek / Wuppertal Institute for Climate Environment and Energy, DE	Modelling a Socially and Environmental Sustainable European Union
SOE1-CT96-1019	Dr. Robin Williams/ Univ. Edinburgh / UK	Social Learning in Multimedia

SOE1-CT96-1020	Prof. John Van Reenen / Inst. Fiscal Studies / UK	Innovation, R&D and Productivity
SOE1-CT96-1035	Prof. Anth on Van Raan / Centre for Science and Technology Studies (CWTS ) / NL	The Role of Europe in World -wide S&T Monitoring and Evaluation in a Context of Global Competition
SOE1-CT96-1036	Dr. Jacqueline Senker Univeristy of Sussex , Science Policy Research Unit (SPRU)/ UK	European Comparison of Public Research Systems
SOE1-CT96-1037	Dr. Anthony Bartzokas / The United Nations University Institute for New Technologies INTECH / NL	Technological and Financial Investment: Manufacturing Firms in Southern Europe
SOE1-CT97-1053	Margareth Sharp / University of Sussex / UK	The Relation between S&T Policies and Broad Industrial Policy
SOE1-CT97-1054	Dr. Eric Verdier/ CNRS/ Paris, FR	Systemes d'Enseignement Superieur et Innovation
SOE1-CT97-1055	Prof. J.L. Gaffard / CNRS / FR	Industrial Dynamics and Employment in Europe
SOE1-CT97-1056	Dr. A. Webster/ Anglia Polytechnic University / UK	Foresight as a Tool for the Management of Knowledge Flows and Innovation
SOE1-CT97-1057	Dr. Ir. B. Elzen / University of Twente / NL	Towards and Interactive Technology Policy - Implications from the Social Shaping of Mobility and Transport Policies for a New Technology Policy Paradigm
SOE1-CT97-1058	Prof. Cristiano Antonelli / Fondazione Rosselli / ITI	Industrial Districts and Local ised Technological Knowledge: The Dynamics of Clustered SME Networking
SOE1-CT97-1059	Mr. W. Garcia -Fontes / Fabra / ES	From Science to Products
SOE1-CT97-1060	Dr. Peter Van den Besselaar / University of Amsterdam / NL	The Self-Organisation of the Euro pean Information Society
SOE1-CT97-1061	Dr. Arne Isaksen / Studies in Technology, Innovation and Economic Policy / NO	SME Policy and the Regional Dimension of Innovation
SOE1-CT97-1062	Prof. D. Foray/ University Dauphine - / FR	Collective Invention and E uropean Policies
SOE1-CT97-1064	M. Gérard Valenduc/ Fondation Travail Université / FR	Flexible Work Practices and Communication Technology
SOE1-CT97-1065	Martin Fransman/ University of Edinburgh / UK	SMEs in Europe and East Asia: Competition, Collaboration and Lessons for Policy Support
SOE1-CT97-1066	Mr. Keith Dickson/ Brunel University / UK	Building Collaborative Networks for New Product Development
SOE1-CT97-1068	Dr.David Wield / Open University / UK	Policy Influences on Technology for Agricultu re: Chemicals, Biotechnology and Seeds
SOE1-CT97-1070	Prof. G. Schienstock/ University of Tampere / FIN	Information Society, Work and the Generation of New Forms of Social Exclusion

SOE1-CT97-1071	Dr. J. Wickham/University of Dublin / IE	Scenarios for a Sustainable Society: Car Transport Systems and the Sociology of Embedded Systems
SOE1-CT97-1072	Prof. L. Engwall/Upsala Universitet / FIN	The Creation of European Management Practice
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SOE2-CT98-2047	Prof. M. Godinho / Centro de Investigação sobre a Economia portuguesa, Lisboa, PT	Strategies and Policies for Systemic Interactions and Convergence in Europe